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The Chicago Drainage Trustees will advertise shortly for proposals for six miles of canal work, between Willow Springs and Summit. The channel will be for a discharge capacity of 300,000 or 600,000 cu. ft. per minute, the latter being recommended by the engineer. The specifications in the case of the larger channel provide for the excavation of 11,400,000 cu. yds. of earth, 500,000 cu. yds. of rock and the building of 40,000 yds. of dry rubble walls. The six miles are divided into six sections, and the specifications are generally similar to those drawn up for the work below Willow Springs which the contractors will begin in a few days.

Work on the Isthmus of Corinth Canal is progressing favorably, and about 3,000 to 4,000 men are said to be employed. The cutting throughout is down to the level of the sea, and in many places trenches have been made as deep as the grade line of the bottom of the canal. These show a sandy and loose shingle, so that it has been considered advisable to build a wall on each side of the cutting to 3¼ ft. above sea level. This work is now being pushed all along the canal. The idea is to excavate what is still necessary before allowing the water to enter. It is expected that the passage through will be opened in the summer of 1893. The railways of Greece are said to be working satisfactorily, and continue to pay fair dividends.

The Manchester Ship Canal is meeting with considerable financial difficulties, owing to the great increase in cost over the engineers' estimates. About 18 months ago when money was required, the city of Manchester voted $15,000,000, which amount it was claimed would be all sufficient. But now a further amount of $7,500,000 is needed. The original estimate was $45,000,000. The authorized capital amounts to about $67,500,000, to which must be added the additional $7,500,000. The "Financial News," of London, says the work is likely to cost $85,000,000 before it is completed. The death of the contractor, Mr. Walker, was a serious blow; engineering difficulties have been met with and accidents have occurred, but, as the paper above referred to states, this does not explain the discrepancy between the original estimates and the actual cost. Much expensive work which is unnecessary at present is said to have been executed, and extravagant mismanagement is charged. The same paper says that the public will not subscribe any money and that the city of Manchester must provide the funds, being too deeply committed to allow the failure of the enterprise. In 1891 there was a financial crisis, the estimates of $45,000,000 having been exceeded, and it was thought that $20,000,000 more would be sufficient to complete the work. The city therefore voted to subscribe $15,000,000 as noted in our issue of April 4, 1891, but this amount has now been spent, the canal is not completed and there is another urgent demand for money. We have referred to this matter editorially.

Work on one section of the new sewerage system of Orange, N. J., has been suspended by the contractors, the Empire Construction Co., pending the settlement of claims for extra work to which the city has objected. A separate system of sewers is being constructed, and the Empire Construction Co., on June 13, 1891, was given the contract for the Parrow Brook section of the storm water sewers, for about $239,000, this section being the largest and most difficult of the two storm water sections. In building this section the company claims that it has had unexpected difficulties with both quicksand and water not set forth in the data upon which its bid was based, and also that it has been caused delay and increased cost by the failure of the city to procure right of way. The only definite claim for damages is said to be $4,900 for pumping water. Aug. 23 the city referred the matter to the Common Council. It is stated that the company was formed especially to undertake this work and that its bid was very low. Capt. Benj. R. Green is president and A. M. Newton, son of the late Gen. Newton, local manager of the company.

The publication of rumors that the Navy Department was keeping secret the records of armor plate tests in which American plates had made an unfavorable showing has been met by a statement from Acting Secretary Soley, in which he says: "There have been absolutely no unsuccessful trials of either nickel or Harvey plates. On the contrary, the uniform results of these trials have been a phenomenal success. No results in any degree approaching them have ever been attained at the tests of any foreign armor, and moreover we can purchase nickel cheaper by 40% under our contract than any one else."

He characterized as absurd the report that changes had been made in the form of the battle ship turrets with a view to benefit the contractors; the contracts for the turret armor for the battle ships are not yet let. The 18-in. side armor for the three battle ships is to be of straight plates, as it was found that no manufacturer in this country could make curved plates of that thickness. For the plates at the extreme end of the vessel, which are of peculiar shape, $600 per ton is paid, and for the plates next to the end, $525 per ton. The remaining plates are straight and cost $500 per ton.

Tests of the pneumatic disappearing gun carriage invented by Mr. Henry A. Spidler, Superintendent of the South Boston Iron Works, were made last week at Sandy Hook. A 10-in. gun was used and 30 shots were fired. The carriage is claimed to possess many advantages over disappearing carriages operated by hydraulic power. In the carriage tested at Sandy Hook the recoil on firing swings the trunnions back through an arc of 120° and lowers the whole gun 8 ft. vertically. The carriage is fitted with hand power mechanism for use in case the pneumatic apparatus is disabled. In tests on Aug. 18 the following was the time required for the various operations by hand power and by pneumatic power:

	Hand power.	Pneumatic power.
Lifting shot and ramming it home	13 m. 23 sec.	21 sec.
Elevating gun from 5° depression to 10° elevation	12 m. 33 sec.	32 sec.
Lowering tray carrying charge to breech	1 m. 2 sec.	10 sec.

The most serious railway accident of the week was a derailment Aug. 20 at Clifford's, Md., on the Annapolis & Baltimore Short Line R. R. The train consisted of a freight car next the engine, a combination baggage and smoking car, and a rear passenger car. Just after crossing a trestle the door of the freight car fell off, one end falling on the track and derailing the passenger car, which rolled down the bank. Of 30 passengers in this car, one was killed, two were fatally injured and died in a few hours and 21 were more or less injured.

A locomotive boiler explosion occurred on the Iron Mountain R. R. at Memphis, Tenn., Aug. 21, when the engine was pushing a heavy freight train. The engineer and fireman were killed.—The boiler of a switch engine in the Georgia Central R. R. yards at Atlanta, Ga., exploded Aug. 18, while hauling a train of empty cars. Six men were on the engine, but none of them were seriously injured. The accident is attributed to the effect of alum in the water.

Three cars were burned in a railway accident at Clapham, England, on Aug. 20, and the fire is reported to have been due to the escape of gas from a cylinder under one of the cars. A guard who was thrown from the train and imprisoned under the debris of the wreck was burned to death.

Electric lighting has been abandoned on the Midland Railway of England, we are informed, after several years' partial use of it, as being too expensive or unreliable, or both for its use, and the company has adopted instead the Pintsch compressed oil gas system as its standard method of illuminating passenger coaches. They have already erected three gas plants at various points along their line, and have ordered lighting equipment for 886 cars.

The natural gas wells and mains at Fort Erie, Ont., are described as follows in a recent consular report.

Natural gas is being found in abundant quantities about 10 miles from Fort Erie, and is being utilized there and in Buffalo, N. Y., both for heating and illuminating purposes. Provincial Natural Gas & Fuel Co. has put down twelve good wells within a radius of eight miles. The average depth of these wells is 860 ft. and size of hole 6 ins. in diameter. Three of these wells produce 5,000,000 cu. ft. each of gas every 24 hours, two of them 3,000,000 cu. ft. each, and the remaining seven over 1,000,000 cu. ft. each.

An 8-in. pipe has been laid from the wells to Fort Erie, which was intended to extend across the river to Buffalo, the distance being about 2,800 ft. They worked at it nearly four weeks, and then abandoned it, leaving about 1,400 ft. of pipe in the river. A 4-in. pipe was then tried, with two tugs and a scow, and successfully laid in about six minutes, this is now supplying a part of Buffalo.

Fort Erie is supplied by a 4-in. pipe, and nearly every house is using it. The gas for Buffalo and Fort Erie all comes from one of the smallest wells.

Since writing the above a 6-in. pipe has been successfully laid across the river in about eight minutes.

The Coosa tunnel on the Columbus & Western Division of the Central Railroad of Georgia, the lining of which caught fire about three months ago, is expected to be ready for trains by Sept. 1. The fire burned away the timber lining near the east end of the tunnel and the material overhead fell in. The work of tunneling through the fallen material was made exceedingly difficult by frequent rains, which caused further slides to occur. The timber lining has now been replaced with a brick arch.

The lighting of Bartholdi's statue of Liberty on Bedloe's Island, New York Harbor, may be much improved if recommendations made to the Lighthouse Board by Maj. D. P. Heap are adopted. He proposes to place two 100-c. p. incandescent lamps in front of each of the 25 windows which form a coronet on the statue. These will be protected from the weather in glazed lanterns with reflectors at the back. Under the balcony of the torch an arc lamp of 2,000 c. p. is proposed with reflectors arranged to throw light on the face of the statue and also to throw a beam of colored light vertically upward.

Bids for the construction of the new Croton dam were opened for the second time by the Aqueduct Commissioners, New York, on Aug. 24. There were five bids, as follows: Jas. S. Coleman, New York, $4,150,573; H. H. Brown, New York, $4,181,464 (same bid on June 29); Timothy J. Sullivan, Albany, N. Y., $4,314,885; John McQuade, New York, $4,403,800; Winston, Crimmins, Washburne & Co., $4,527,769 (against $4,763,449 on June 29). The bids submitted on June 29 ranged from $3,527,640, by the Ryan & McDonald Construction Co., Baltimore, Md., to $5,540,908, by Wm. Russell Allen and others, St. Louis. The estimate made by Chief Engineer A. Fteley, M. Am. Soc. C. E., was $4,574,820. The Aqueduct Commissioners rejected the previous bids because, as stated in their own language in our issue of Aug. 4, they regarded the lowness of the lowest bid "as offset by the limited financial responsibility of the corporation making the bid."

It will be seen that the highest and lowest bids submitted at the reletting varied by only $377,196, and that they were all beneath the engineer's estimate, made public at, or since the first letting, all of which is not at all surprising. The lowest bid on Aug. 24 was $424,247 below the engineer's estimate, while the lowest bid June 29, was $1,047,180 below his estimate. The highest bid at the reopening was only $47,051 below the engineer's estimate, while at the first opening it was $975,178 above Mr. Fteley's estimate. Only two of the six bidders on June 29 put in bids on Aug. 24, and of these, one bid the same amount as before, and the other, the highest bidder, deducted $185,680. The detailed bids by quantities were given in our issue of July 7.

DISTORTION OF RAILWAY TRACK BY THE GREAT JAPANESE EARTHQUAKE.

We are indebted to a recent number of "Stahl und Eisen" for the accompanying view of the peculiar distortion of a section of Japanese railway track caused by the terrific earthquake of Oct. 28, 1891, which killed and wounded 15,000 people and destroyed nearly $100,000,000 worth of property. The engraving shows a section of track near the Kisogawa bridge, which was destroyed at the same time. It will be seen upon close inspection that in some places the whole track has moved sidewise, while in others the rails and ties only have moved, independently of the ballast, resulting in the peculiar zig-zag distortion of the track shown. In this connection we may note that an almost precisely similar distortion of railway track was caused by the earthquake at Charleston, S. C., in 1886, and was illustrated by us at the time. The two views almost seem as if they were for the same track. Some further illustrations of the effects of the great Japanese earthquake were given in our issue of Jan. 9, 1892.

SEWAGE PURIFICATION IN AMERICA.

(With inset.—Continued from p. 129.)

Marlborough, Mass.

As explained in our issue of Aug. 4, the city of Boston was largely influential in securing the introduction of a sewage purification system at Marlborough, and it may be added that it agreed to pay $62,000 toward the expense of the system, which, we understand, was the estimated extra cost for the sewage disposal plant. As shown by the map of this system, Fig. 4, the sewage is now entirely removed from the drainage area of the Boston waterworks. A separate system of sewerage is in use at Marlborough, with downward intermittent filtration for purification, as at South Framingham and at Gardner. On June 23, 1892, there were about 350 sewer connections. To the close of 1891 there were about 50 sewer connections only. New connections are being made at the rate of five a day. As the total number of water connections at the close of 1890 was 1,794, and the population of the town in 1890 was 13,805, it is evident that at present the amount of sewage to be purified is small compared with what it will be in the future.

The town introduced water-works in 1883, and the consumption of water in the early part of this year was about 325,000 gallons a day, but at 4:30 p. m., May 12, 1892, after a dry spell, the flow through the outlet sewer was at the rate of 330,000 gallons a day, and on May 25, 1892, at 9 a. m., after heavy rains, the rate of flow was 790,000 gallons a day. The measurements on each date were made by observing the time taken to fill the separating tank once.

Ground water, of course, is the only explanation for this large flow through the sewers, for, as has been stated, not more than one-fifth of the water consumers are connected with sewers. Unfortunately, Marlborough is not the only town where an excessive amount of ground water finds its way into the sewers. Where sewage purification is attempted or the sewage is pumped, this is a serious and expensive trouble. The city of Boston would not allow Marlborough to put in underdrains because it feared that sewage would pass through defective sewer joints, and into the drains, and thus finally into the Boston water supply. If the underdrains could not be discharged into natural water courses tributary to the Boston water supply, then the ground water might as well work into the sewers, as it now does.

Mr. M. M. Tidd, M. Am. Soc., C. E., of Boston, Mass., was the engineer, with Mr. Fred. Coffin, C. E., as principal assistant of the system. Mr. Desmond Fitz Gerald, M. Am. Soc. C. E., represented the city of Boston. The construction of the plant was in charge of Mr. B. R. Felton, C. E., as resident engineer for Mr. Tidd. Since March, 1892, Mr. Felton has been city engineer of Marlborough.

The sewage filtration beds are located about two miles, in an air line, from the outskirts of the village, and some 3½ miles from the last house connection, measured on the pipe line. The nearest house is about 1,000 ft. from the beds. There are two other houses about 1,500 ft. away, and no more within about a mile.

The sewage passes from the village to the disposal area, through the outlet sewer mentioned, which is of vitrified pipe. A separating or settling tank removes the sludge from the sewage, after which the sewage passes through iron pipes to the several filter beds, of which there are now 14 in use, besides the six small beds used for emptying the sludge.

The arrangement and details of the purification plant are shown by the accompanying drawings, kindly furnished by the engineer, Mr. Tidd. Fig. 5 is a plan of the filter beds. Only 20 of these, including the 6 sludge beds, are yet in use, but it is proposed to use 51 beds eventually. The 14 filter beds now in use, with their dividing embankments, cover about 13 acres. In the whole tract bought by the city there are 60 acres.

The separating or sludge tank is shown in plan and section by Fig. 6. It is of brick, in two compartments, with gates permitting sewage to be admitted to or drawn from either one at will.

The course of the sewage in passing through the tank is shown by the drawings. The screens perform only a slight service, as most of the solid matter settles before the sewage reaches the screens.

The sludge can be removed from either tank to the sludge carrier, by opening the cleaning-out gate. The floor over the tanks is formed by iron gratings supported by I beams, 3¼ ft. c. to c.

The character of the 24-in. influent gates, and the 18-in. gate, which controls the passage of sewage directly to the beds, through the pipe on the partition wall, are shown by the 18-in. lift-gate in Fig. 7. There is also shown in Fig. 8 an 18-in. swinging gate, which is apparently used at the effluent end of the tank.

Fig. 9 shows, in detail, the screen used in the separating tank.

The sewage passes from the top of the tank through iron pipes along the embankments to the several beds, and discharges onto the beds through gates and short branches, the bed at the point of discharge being paved, all as shown in Figs. 10 and 11. Fig. 10 gives a plan and section of the outlet to the beds, and Fig. 11 shows the two-way 10-in. vertical gates used. A single gate constructed on the same principle as the two-way, is used where only one gate is needed.

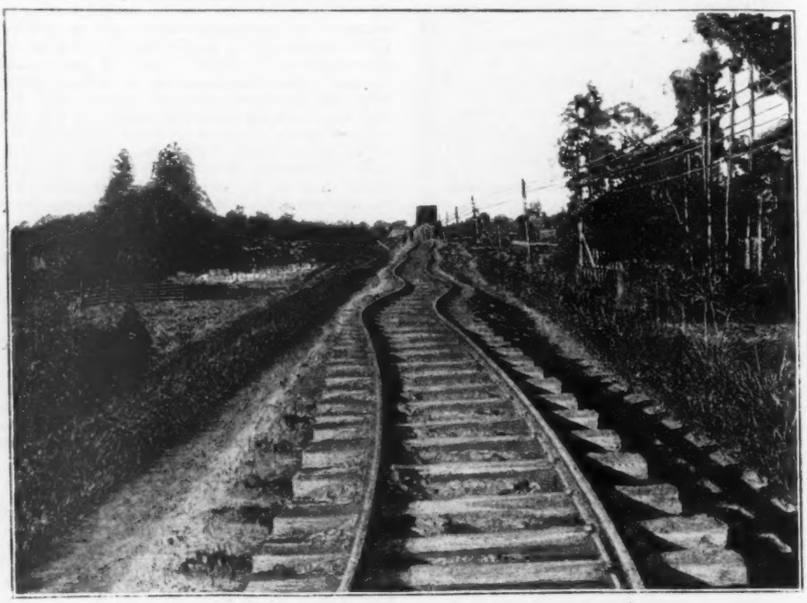
The sludge passes through the cleaning-out gate, already mentioned, to the sludge carrier, shown in detail in Fig. 12.

Sludge was first removed from the tank in April, 1892. It remained upon one of the beds for a month, instead of being speedily removed, and became offensive. A farmer drew it away for it. On May 25 the sludge was removed from the tank the second time, and on June 11 the third time, in each case a farmer hauling from the bed for it. The tank filled full, or nearly full, of sludge, each of the last two times.

The crust that forms on top of the filter beds, consisting of minute particles of matter suspended in the sewage, is harrowed in from time to time.

The effluent from the beds discharges through underdrains into Hop and Wash Brooks, which empty into the Sudbury River. These beds were visited June 17, 1892, at which time they seemed to be doing good work, and presented no unpleasant features. A strong breeze was blowing over the beds, but at their windward side only a slight odor was noticed.

The cost of the tank, tank house, filter beds, and all appurtances, including engineering and excluding land, was $21,720. The outlet sewer was carried 2½ miles further than it would have been, had not sewage purification been adopted. The total extra cost caused by the construction of this extra pipe line, and the filtration beds and appurtenances was about $62,000, and will be, or has been, met by the city of Boston as a return for removing sewage from its water supply.



THE EFFECT OF AN EARTHQUAKE ON RAILWAY TRACK.

PROPOSED HIGHWAY LAW FOR CONNECTICUT.

The following is the substance of a new highway law prepared by a committee of the Connecticut State Board of Trade, which will advocate it before the legislature. The appointment of the committee was the outgrowth of an address on highway improvement made at a recent meeting of the Board by Mr. Theodore H. McKenzie, M. Am. Soc. C. E., secretary and treasurer of the Southington Water Co.

Sec. 1. There shall be appointed by the Governor three Highway Commissioners to hold office for 2, 4 and 6 years, respectively, vacancies to be filled as fast as they occur.

Sec. 2. At least one of the Highway Commissioners shall be a capable and experienced civil engineer. Each member of the Board shall receive $8 per day and his actual expenses while officially employed.

Secs. 3, 4 and 5. The office of the Board shall be at the Capitol. The Board may employ a clerk at a salary of not over $1,500 per annum. The Board shall keep a record of its proceedings and make an annual report to the legislature.

Sec. 6. The Board shall classify the highways of the state, and determine what highways shall be, and be deemed to be, state highways, to be treated as hereinafter provided; and the Board shall then prepare a proper map and description of the state highways, which map and description as approved by them, and as at any time thereafter by them amended or enlarged, shall be, and be deemed to be, the map and description of the system of the state highways.

Sec. 7. The Board shall provide for the improvement

and development of all parts of the state highways, and shall provide surveys, specifications and, when necessary, profiles, of any and all changes in existing highways and for the layout of new highways to carry out such improvements and developments. The Board shall notify the municipal authorities having charge of highways in each town in which an improvement is to be made of such proposed improvement, and, after the plans of such improvement have been exhibited to such municipal authorities, and, after hearing any and all offered objections and suggestions, the Board may finally determine the course, route, width, paving and all other characteristics of the highway to be improved, developed or laid out. Said municipal authorities shall provide all bridges upon the state highways called for by said plans; and any change in layout, or widening, of such highway shall be made by, and at the expense of, the town in which said highway is located; and when additional land is needed for such improvement the selectment of the town shall at once proceed to acquire the same. But all specifications approved by the Board shall require the construction of a macadamized, telford, or other stone road, which will at all seasons of the year be firm, smooth, and convenient for travel, and such specification shall require a wagon path at least 16 ft. in width; provided, however, that in exceptional cases, and for cause, the Board may order for such construction the substitution of gravel or other material.

Sec. 8. The Board may make any and all improvements by contract, but all contracts made shall be offered to fair competition and shall provide for indemnity against accidents and damages during construction; and the Board may appoint when necessary an inspector or superintendent of work.

Sec. 9. All the expense of constructing and developing the state highways, except for bridges, changes in layout and land damages, shall be paid by the state upon the approval of the Board, but such expense shall not exceed $150,000 in any one year.

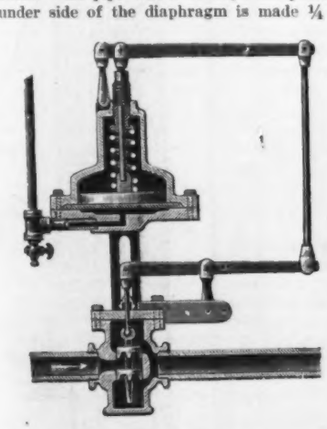
Sec. 10. The Board in improving the state highways shall regard the claims of all parts of the state so far as consistent with public convenience.

Sec. 11. The Board shall have all power and authority necessary to carry out the provisions of the law.

Sec. 12 Any state highway constructed or improved under the provisions of this act shall forever thereafter be maintained and kept in repair to the satisfaction of the Board by, and at, the expense of the town in which said highway is located.

ACTON'S HYDRAULIC PRESSURE REGULATOR.

The pressure regulator, or reducing valve, of which a section is shown herewith, is designed for use wherever a steady water pressure is desired lower than that furnished by mains or pumps. Its working is evident from the illustration. The diaphragm is of composition metal, and is 1-32 in. in thickness. The pipe which conveys the pressure to the under side of the diaphragm is made ¼ in. in



A Hydraulic Reducing Valve.

diameter, where the reducing valve is placed near a pump, in order that the contracted passage may throttle the flow and prevent any jumping of the valve. For use on water-works mains the pipe is made ⅛ in. in diameter. The manufacturer claims the leakage of the throttle valve to be practically nil. A small amount of sediment collects on top and aids in keeping it tight, and the form of the valve and seat permits the valve to move up to contact with the seat, notwithstanding wear.

PROGRESS OF WORK ON THE BUSK TUNNEL, COLORADO.

Work on the Busk Tunnel through Saguache Mountain of the Continental Divide on the Colorado Midland Ry. is progressing rather slowly owing to the bad character of the material penetrated. A brief description of the tunnel and the plant used in its excavation was given in our issue of Jan. 17, 1891. It is being built by the Colorado Midland Ry. Co. on its line between Busk and Ivanhoe, Colo., and will save about 530 ft. of elevation, seven miles in distance, and 2% of curvature. Its length is 9,400 ft., and its section 15×21 ft. Work was begun on the approaches Aug. 1, 1890.

The ground through which the tunnel has been driven has been very changeable, very seldom remaining the same for two weeks at a time. The material encountered is gray granite, very hard and difficult to drill in places, and considerably broken and blocky. In other places the rock seems to have been decomposed by the action of some acid, and while it appears quite hard when the heading is first being driven through it, it disintegrates on exposure to the atmosphere and causes very great trouble, unless it is caught up quickly with the timbers. Wide seams of talc saturated with water have also caused trouble, and in two instances large reservoirs of liquid mud have been encountered, from which, when they were tapped, the mud and water rushed into the tunnel with such velocity that it was difficult for the men to escape. In one case one of the workmen was overtaken and smothered by the in-rushing material before he could escape. At the present time both headings are in fairly good material, although it is necessary to continue timbering, and it is hoped that the rate of progress will be considerably increased.

The following table shows the total heading, bench and tunnel, driven at both the Busk and Ivanhoe ends up to Aug. 1, 1892:

	Heading, feet.	Bench, feet.	Av'age, feet.
Busk end	3,080	3,020	3,050
Ivanhoe end	2,464	2,402	2,433
Total	5,544	5,422	5,483

The monthly progress since the beginning of the excavation in September, 1890, up to and including July, 1892, has been as follows:

	Feet.		Feet.
September, 1890	27	September, 1891	285
October, "	149	October, "	247
November, "	280.5	November, "	241
December, "	286.5	December, "	241
January, 1891	308.5	January, 1892	282
February, "	298.5	February, "	217
March, "	284	March, "	143
April, "	300	April, "	143
May, "	335	May, "	268
June, "	273	June, "	186
July, "	255	July, "	217
August, "	214		
		Total	5,483

Since the date of our former description, Jan. 17, 1891, there has been a considerable addition to the machinery employed on the tunnel. At the Ivanhoe end a 20×24-in. Norwalk compressor, a 16×20-in. Ingersoll compressor, a No. 7 Cameron pump, a Deane Duplex pump with 14-in. steam cylinders and 8½-in. water cylinders, a 20-HP. engine, a No. 6 Baker blower, and a small locomotive for handling dump cars in and out the tunnel, have been added. At the Busk end the additions consist of a locomotive engine, a 20-HP. stationary engine and a No. 6 Baker blower. The tunnel is well equipped with machinery, and the organization of labor is very fair.

Both headings are now passing under the main rib of the mountain, where the work is difficult, and it is expected that after this point is passed the progress will be more rapid. The work is being done under the supervision of Mr. B. H. Bryant, Chief Engineer, with headquarters at Colorado Springs, Colo.

THE ELECTRIC PERCUSSION DRILL IN THEORY AND IN PRACTICE.

In our issue of May 16, 1891, we published an extended description of the electric percussion drill then just placed on the market by the Edison General Electric Co. Since that time the drill has been put into use quite extensively and the result of experience with it has been to bring about considerable changes in its construction. At the last meeting of the American Institute of Electrical Engineers the inventor of the drill above referred to, Mr. Harry N. Marvin, of Syracuse, N. Y., read a paper describing the various types of electric percussion drills and the principles controlling their design. We give the substance of it as follows:

Wherever rock is to be excavated, in mining, tunneling or quarrying, there of necessity we find the percussion drill. Until about a year ago two types of drills held the field, the hand drill and the direct acting steam or air drill. With the extension of electrical methods of power transmission to mining operations came the urgent demand for an electrically operated percussion drill.

The mechanical and electrical requirements of this machine are particularly severe; it is called upon to continuously endure an action that is, in almost all other machinery, studiously avoided, namely, a practically uncushioned reciprocation and a blow upon substances harder than cast iron. The general requirements of an electric percussion drill for mining work are that it shall be light enough to be quickly handled by two or three men; it must be powerful enough to compete with an air drill that absorbs 8 or 10 HP.; it must be so simple in its design that it can readily be repaired by an ordinary mechanic without electrical experience; it must be so constructed that the complete machine and its several parts can be soaked in mud and water without injury; it should be incapable of burning out; it must be able to endure almost any amount of the roughest handling without injury, and the materials employed should be as little subject to crystallization as possible.

My experience suggests the following elements of construction to be avoided: Traveling conductors, commutating or current shifting devices, sliding contacts, spring contacts, cotton insulated wire and all insulating material capable of carbonization, switches, lamination of the moving parts, close fittings and joints liable to be impaired by considerable wear, all constructions liable to be impaired by careless or unskilled attention. For the benefit of those unfamiliar with the actions of the air drill, I will state that the general practice at present is to give the machine a stroke of from 5 to 7 ins., to strike as nearly as possible an uncushioned blow upon the rock, and to make as many blows per minute as the power applied will develop, usually from 200 to 400 per minute. It is found that a stroke of about 5 ins. is necessary to properly free the hole from mud.

In the electrical solution of the problem the solenoid and plunger affords the simplest method of developing this action, and most of the work in this field has been confined to this line. After much experimental work with divided solenoids and commutating devices mounted upon the drill, I abandoned these methods, and in 1888 devised the system of operation that is at present rather well known, but for clearness this may be illustrated.

Fig. 1 shows an ordinary continuous current dynamo having two opposite points of its armature connected to a solid collecting ring and a half ring, respectively. The outer terminals of the drill coils M1 and M2 are connected by line wires to the two brushes, alternately bearing upon the half ring. The inner terminals of the coils are joined and led to the solid ring. It appears that as the armature revolves, current impulses are directed into the drill coils in alternation, causing a reciprocation of the plunger in synchronism with the dynamo armature. It will be noticed that the action here closely resembles the action of a steam engine, force being exerted first in one direction and then in the other, one end of the cylinder being idle while the other end is active. Of course, connections are such that the polarity of the plunger is never reversed. This system simplifies to the utmost the construction of the drill and enables it to be so designed as to satisfy all of the conditions before mentioned. The complications of this system are more apparent in theory than in practice. Three wires are required, but once placed they give no further trouble. The generator can be used to develop continuous currents and pulsating currents at the same time if desired, but I believe that it is better practice to use a separately excited drill generator without regular commutator. The machine then becomes extremely simple. I have found it desirable to run these drills at a speed of about 400 strokes per minute, a rather low speed for small dynamos. This difficulty may be avoided at the expense of simplicity in several ways. One method is shown in Fig. 2. The regular commutator of a continuous current armature is equipped with a pair of revolving brushes B—B1, one of which connects to the solid ring of the drill circuit commutator and the other to the half ring. In this manner pulsations are developed in the drill circuit as the brushes B—B1 are rotated, and with a frequency entirely independent of the armature speed. With this arrangement we are also able to take off 100 volt alternating currents from a commutator that is also suplying a 500 volt continuous current circuit, by spacing the brushes B and B1, an amount less than 180°.

Any method of reducing the frequency of the pulsations is shown in Fig. 3, where the drill commutator

is geared to the dynamo shaft, reducing the frequency to one-half the speed of the generator.

The general plan of admitting the current alternately to the two drill circuits, one circuit being idle while

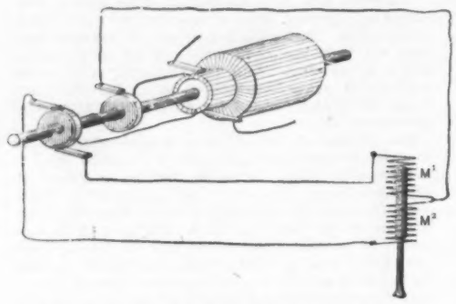


Fig. 1 Diagram Illustrating Reciprocating Motion Produced by Solenoid.

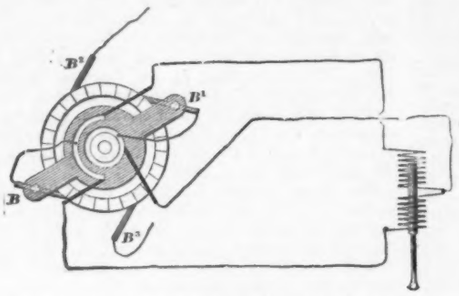


Fig. 2. Method of Obtaining Alternating Current From Continuous Current Dynamo.

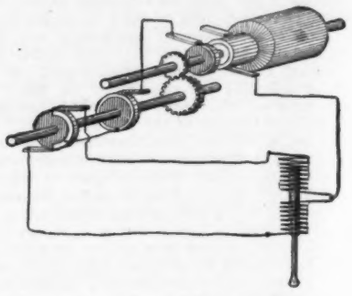


Fig. 3. Commutator Geared to Dynamo to Reduce Frequency of Pulsations.

the other is active, characterizes all the above methods. This may be called plan A.

Another general plan of drill operation, which I call Plan B, has been developed to some extent by the late Mr. Van Depoele. This plan is based on a difference of phase of current in the two coils, and is shown in its simplest form in Fig 4. The two outer drill wires are connected to the two regular brushes of the armature A, and the middle wire connects to the solid ring connected to one point of the armature. As the armature revolves, current rises in one drill coil and falls in the other, producing the reciprocation of the plunger. An armature giving two alternating currents of 90° difference of phase may also be used, but with the disadvantage of reversing the polarity of the drill plunger. The above appears to be less efficient than Plan A for the reason that the drill coils are constantly working against each other, and being heated up by current opposing the action of the drill.

The requirements of construction and service have thus far induced me to employ a rather low voltage in the operation of drills, our present practice being to use about 100 volts alternating upon the drill. I have

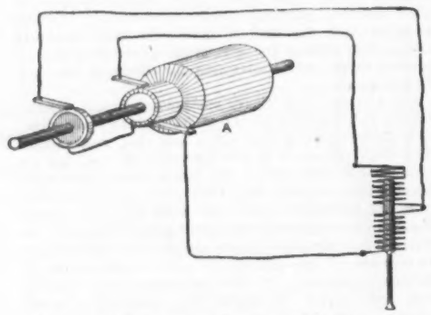


Fig. 4. Van Depoele System of Operating Solenoids.

employed several methods of operating drills from high voltage circuits.

Referring to Fig. 2, if the regular brushes B2 B3 be connected to a 500 volt circuit, the armature will run as a motor, and if the rotating brushes B B1 be spaced by a suitable amount, less than 180°, they will take off the pulsating current for the drill circuit at, say, 100 volts.

By another method a 1,000 volt alternating circuit is led from the prime generator to the vicinity of the mine, where it passes through the primary of a converter in which the voltage is reduced to 100 volts. A small motor running in synchronism with the generator directs the alternate pulsations into the drill circuits.

Turning now to the drill construction, Fig. 5 shows the first form in which the percussion drill was put upon the market. As appears in the sketch, the machine consists of a 7-in. boiler tube provided with a suitable mounting. Within the tube are two solenoids B B1, a rotating device and a cushion spring. Traveling through the coils is a two-in. plunger D, the middle portion of which is of iron; the upper end is of brass and is rifled as shown to fit the rotating device; the lower end is also of brass and is enlarged at the end into a chuck to hold the bit. The three sections of the plunger are welded together. The weight of this plunger was 38 lbs. This machine was designed to make 600 blows per minute with a 3-in. to 4-in. stroke.

The first of these machines to be put into a mine was that started in May, 1891, in the Black Bear mine at Gem, Idaho. This was, I believe, the first commercial electric percussion drill plant ever operated. During the next few months several other mines and quarries were equipped with these drills, with the general result that where the rock was not excessively hard the work was fairly satisfactory, but in extremely hard rock several defects developed. The brass portion of the plunger would crystallize and break a short distance above the chuck. Under the severe strain of continuous work in hard rock the coils would become so heated as to ground, and the spring connections between the cable and the coils would give out. The construction of these drill coils deserves special description. The coil is constructed as follows: Upon a brass spool, the body and heads of which are insulated with mica, is wound a bare copper wire of square section; this wire is insulated as it is wound with mica. The complete coil is wrapped with mica and a metal tube slipped over the whole and soldered to the coil heads, making the completed coil water-proof and heat-proof, as it is insulated with mica alone, nothing but mica and metal being used in its construction. The trouble with our first coils was that they were soldered up with a comparatively soft solder, and when the coils got very hot this solder softened, the joints opened, and oil and dirt getting in carbonized and developed a ground. As an example of the treatment these drills received I will state that while visiting one of our drill plants, that was used for railway grading on the Great Northern Railway in Idaho, I saw the men dump one of these drills bodily off from a flat car onto a dump of broken stone, down which the drill rolled some 20 ft. I might add that this was one of our most successful plants, 18-ft. holes being regularly drilled in granite rock.

In view of the defects mentioned, the design of the machine was altered. The plunger has been enlarged to 2¾ ins., and is what I call the double magnet type. The forward part is now made of steel, the rifled part is also of steel, and the connecting piece is of brass. This design gives a solid steel chuck and brings the brass part of the plunger within the drill body. The coils are now incased in boiler tube jackets braced up with hard spelter and are heated to a bright red in process of manufacture. The spring connections have been abandoned, and solid set-screw connections now connect the cable to the drill. A switch is inserted in the cable near the drill. This machine seems to overcome the defects of the old drill and has thus far proved very satisfactory. This machine takes a stroke of about 5 ins. and runs at about 380 blows per minute. This longer stroke is found more effective in keeping the hole free from mud.

Fig. 6 shows a still later type of drill that I have recently built and which promises to be much better than the others. The outside dimensions of this machine are about the same as the type A machines, but the plunger of this machine is a solid steel forging and 4 ins. in diameter. No brass is used in the plunger, the metal being reduced in section where it passes through the front head. The ratchet device is similar to that used in air drills, and, in fact, the whole design of the machine quite closely follows the air drill construction. This machine takes a stroke of from 6½ to 7½ ins., and makes about 380 blows per minute; the plunger weighs 80 lbs.

A study of the operations of these machines presents many interesting features. In Fig. 7 is shown what I term an energy curve of the machine. This curve is obtained in a manner similar to an indicator card of a steam engine. A cylinder is mounted parallel to the drill rod and is geared to the armature shaft in such a manner that it rotates in synchronism with it. A pencil carried by the drill rod rests upon the cylinder A; it appears that as the drill rod reciprocates and the cylinder A rotates, a curve will be traced by the pencil. Fig. 7 shows such a curve. The direction of motion of the paper being from left to right, it appears that the angle X of the curve at any point indicates the velocity of the plunger at the instant. A is the point where the plunger strikes the rock, and the sharp rebound is shown by the angle. The concave character of the curve shows the backward acceleration of the plunger. The buffing spring is encountered at S and the angles at S and S1 show that there is little loss in the spring. The angle X gives the final velocity of the plunger when it strikes the rock. A simple calculation gives the energy of the blow in foot pounds. This affords a good method of comparison between the different machines and conditions. The general character of the curve reveals the general action of the forces during the stroke. The curve in Fig. 8, for example, shows

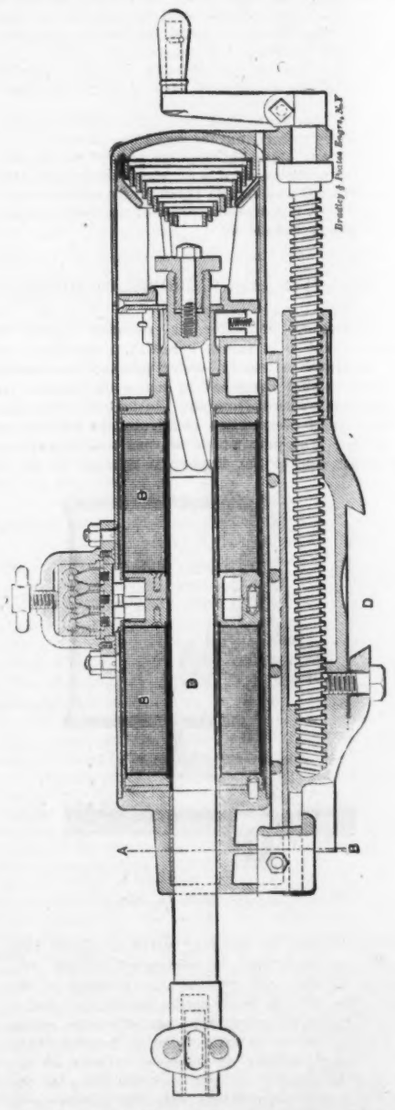


Fig. 5. Original Form of Marvin Percussion Drill.

that the drill rebounded sharply at A and then stood still for a considerable time at B, indicating that the stroke was too short for the power applied and the frequency of the stroke.

The efficiency of the above machines compared with other forms of electro motors is, of course, low; but this factor is of comparatively little moment in percussion drill work. It is far more important that the machine should be able to endure the development of a large amount of power with a small weight than that it should be highly efficient. It would seem that the general mechanical design of these machines admits of greater durability and simplicity of construction than air drills, as there are no steam tight joints required, and a very great wear upon the moving parts does not reduce the effectiveness of the drill. The general flexibility of the electrical system and its peculiar adaptation to mining work are well recognized, but it has been urged that for drill work compressed air is a necessary motor for ventilation. A careful investigation of this matter reveals the fact that there is little or no weight in this objection. The instances are extremely rare where compressed air is relied upon for ventilation, and I have found few miners who considered this matter of importance.

Although the introduction of the percussion drill has been attended with many difficulties, I believe that the obstacles have been so far overcome that the machine is to-day in thoroughly practical shape.

AN AUTOMATIC CIRCUIT CLOSER FOR TELEPHONE EXCHANGES.

A recent invention in telephony is an automatic machine designed to do away with the necessity of operators to make connections at the central exchange. The ordinary instruments are used, and the additional mechanism consists of five keys placed beside each subscriber's instrument and a "circuit closer" at the central office. The keys at the subscriber's instrument are marked, "units," "tens," "hundreds," "thousands," and "release." If the subscriber wishes to connect with number 1,236, he presses the thousands key once, the hundreds key twice, the tens key three times, and the units key six times. An ingenious, but necessarily rather complicated machine at the central office is moved by these successive electric impulses, and a circuit closing needle is made to turn around and give connection with the desired wire. When connection is made, the bell of the person called is rung as in the ordinary system. After the conversation is over a pressure of the release key opens the circuit.

While the system is certainly ingenious, it is questionable whether the expense and trouble of maintaining the delicate apparatus in order, would not go a long way toward offsetting the saving in the wages of the usual attendants. It may be said, too, that in many exchanges, it is often difficult for two subscribers to hear each other, and at the same time each can easily hear the central office. The message is then taken by the attendant there, and repeated to the one for whom it is intended. It seems quite likely, however, that on small exchanges, or for connecting the different departments of a manufacturing establishment, the system could be made so simple as to be very valuable. It is on small exchanges with very few subscribers that the cost of attendance at the central office is greatest. If the expiration of the fundamental Bell patents next year should result in the extension of the telephone into the smaller towns and cities, the automatic appliance above described may be an important aid to its success. It is stated that an exchange using these instruments is to be at once installed at La Porte, Ind. The invention is controlled by the Strowger Automatic Telephone Exchange Co., of New York and Chicago.

CHANGE OF GAGE ON THE GREAT WESTERN RAILWAY AND IN THE UNITED STATES.

When the original line of the Great Western Ry. was built, from London to Bristol, 118 miles, Mr. I. K. Brunel, its projector and chief engineer, advocated and secured the adoption of a gage of 7 ft., and a considerable system of connecting lines, which were built subsequently, had the same gage. As the railway system extended, these roads began to meet roads built to the now "standard" gage of 4 ft. 8½ ins., as adopted by Mr. Stephenson, and then ensued the "battle of the gages," which culminated in a fight over the proposed Bristol and Birmingham railway, which would have formed an outlet for the broad gage to a new district. The party advocating the standard, or what was then called the "narrow" gage, however, was successful, and the extension of the broad gage beyond its own territory thereby prevented. When in later years the Great Western Ry. formed a part of the general railway system, and had connections with many standard gage roads, the break of bulk for passengers and freight became very troublesome, as similar breaks did in this country, and on a considerable part of the main line a third rail was laid, forming the mixed gage, and beginning in 1869 some parts of the line were changed to the standard gage. In 1845 this railway had a length of 274 miles, all laid with broad gage track. In 1854 the mixed gage was first introduced. In 1867, in spite of the general adoption of the standard gage by other railways,

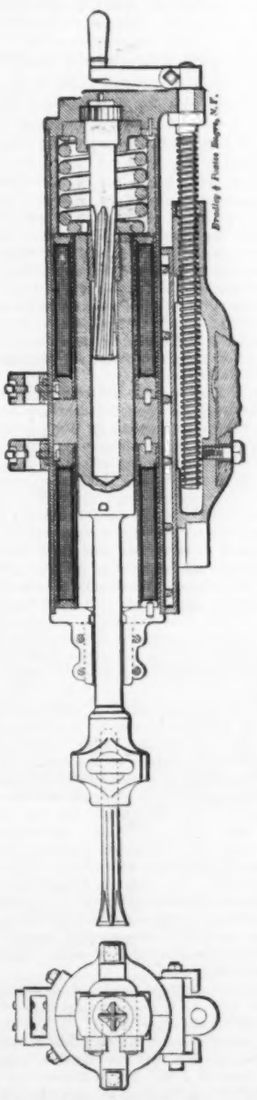
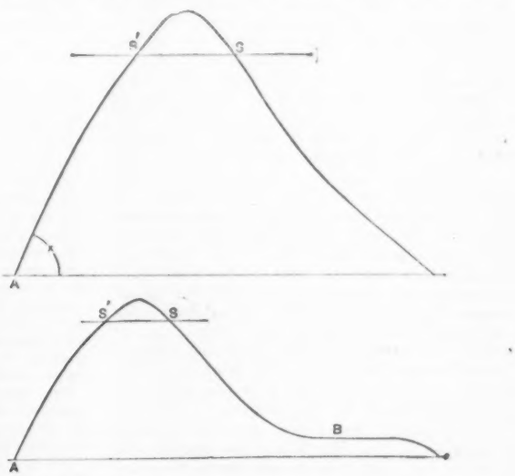


Fig. 6. Latest Form of Marvin Drill.



Figs. 7 and 8. Velocity Diagrams of Electric Drill Strokes.

this road had 1,450 miles of broad gage, but this was gradually reduced year by year, until at the beginning of 1892, there were only about 200 miles of broad gage, and 420 miles of mixed gage, the remaining 1,880 miles of the Great Western Railway system being all of standard gage. When the change was made on the South Wales division, about 1878, a greater mileage was changed than that just completed, but as that was a double track line, each track was closed for two weeks at a time, and all traffic carried on the one track. Most of the 200 miles recently changed was single track.

The main line from London to Penzance, in the west of England, is 326 miles in length, and has the mixed gage as far west as Exeter, 194 miles, but west of Exeter (between that place and Truro, in Cornwall), there were about 200 miles of main and branch lines with the broad gage only. For some years past the eventual abandonment of this gage has been foreseen, and little rolling stock has been built for it, except that some of the modern long cars were placed on broad gage frames and trucks, with a view to replacing the bodies on standard gage frames and trucks. In 1891 it was definitely decided to abandon the last of the broad gage, and May, 1892, was selected as the time for the change, as noted in our issue of Nov. 28, 1891. The original track, of which about 400 miles are still in use, was laid with bridge rails on longitudinal timbers, connected by timber transoms and iron tie rods, as illustrated in Engineering News, Feb. 21, 1891, and June 23, 1892, but all new work has been laid with the standard type of English track, consisting of bull-head steel rails in cast iron chairs, secured to wooden cross-ties.

The entire change of the 200 miles of broad gage above referred to was made on May 21 and 22, traffic being suspended west of Exeter from Friday night, May 20, to Sunday night, May 22; arrangements for through traffic from Plymouth eastward being made with the London & Southwestern Ry. As much preparatory work as possible had been done beforehand; the ballast was removed from the inner side of one of the longitudinals, and some of the transoms were then sawed off to the required length. On the days of the change, the remainder of the transoms were cut, and gangs of men with crowbars shifted the rail and longitudinal in bodily for a distance of 2 ft. 3½ ins. to the new position for standard gage. They moved the line for 6 or 8 ins. at a time for a length of 50 or 60 ft., and then worked back, moving it in another 6 or 8 ins., and so on. The track had then to be lined and surfaced, the shorter tie-rods put in and bolted up, and the ballast relaid and tamped. The time occupied was about 31 hours; 5 a. m. to 9 p. m. on May 21, and 5 a. m. to 8 p. m. on May 22. The work included many switches, turnouts, etc. The cost of the work, including alterations to rolling stock, etc., is estimated at $5,000,000. On the length of line changed there were about 50 stations, at each of which was a more or less complicated system of switches, frogs, crossovers, turnouts and side tracks, with switch and signal interlocking plant, all of which was changed and in full operation at the same time as the track proper. In some places station platforms had to be altered. About 5,000 men were employed. They were divided into gangs of 20 men and one foreman to each mile, and each section of three miles was in charge of a track inspector. The men supplied their own food, but an unlimited supply of oatmeal water was furnished by the company, no alcoholic liquor being allowed. Tobacco was furnished the men by one of the directors who owns a tobacco manufactory.

The whole work was completed and ready for traffic on the night of Sunday, May 22. The last through train on the broad gage ran through from the Paddington terminal station, in London, to Pen-

zance on the night of May 20. In addition to the change of gage the parts of the line west of Exeter which have a single track will be doubled, and masonry viaducts built to replace the old single track wooden viaducts.

Extensive preparations had also to be made for changing the broad gage locomotives and cars, and with the modern equipment this was readily done, the frames having been built with a view to this change, while some of the car bodies were removed to standard gage frames, leaving the original frames to be changed later. In all about 4,000 engines and cars had to be altered, and 25 miles of sidetrack for their accommodation were laid at Swindon, where the company's locomotive and car shops are situated. For recommencing traffic from the western end of the line, standard gage equipment was sent down on broad gage flat cars.

In connection with this record, some brief notes as to similar work in the United States may be of interest. In the United States there has been a great deal of changing gage from broad to standard gage during the past 20 years. The Ohio & Mississippi Ry. changed its gage from 5 ft. to 4 ft. 8½ ins. on its Louisville branch, 53 miles, on July 16, 1871, and on its main line from St. Louis to Cincinnati, 340 miles, on July 23, 1871. Both rails were shifted in. The number of men was nine laborers per mile and one foreman for each five miles. Some of the spikes had been drawn previously and other preparations made. Within 16 hours from 4 a. m. the entire line had been tested by a narrow gage train and found in perfect condition. The movement of trains was not seriously interfered with, sufficient freight and passenger cars for the traffic of the road having been transferred to standard gage trucks. In the same year the Grand Trunk Ry., of Canada, changed its gage from the broad gage of 5 ft. 6 ins. (originally adopted on account of having been adopted by the English Government for the railways of India, as pointed out in our issue of Aug. 4) to the standard gage of 4 ft. 8½ ins. The 5 ft. 6 ins. gage is now only retained in Canada on the Carillon & Grenville Ry., 13 miles, and this will be changed this year.

The New York, Pennsylvania & Ohio R. R. (then the Atlantic & Great Western R. R.) changed 218 miles from 6 ft. to 4 ft. 8½ ins. gage on June 22, 1880, with a force of 2,385 men, including foremen. The details of this work on the five divisions, as taken from the official records, we tabulate as follows:

	Div. 4.	Div. 5.	Div. 6.	Div. 7.	Div. 8.	Total.
Length, miles	27.50	45.50	42.75	54.75	47.5	218.0
Force, including men	349	510	480	566	480	2,385
No. of men per mile	13	11	11	10	10	11
Main track begun, a. m.	4.06	4.01	4.06	4.03	4.08	.....
Main track completed, a. m.	8.13	7.37	7.23	8.28	8.33	.....
Spikes driven per rail	7	6	6	5	5¼	.....
Spikes pulled per rail	5	5	5	5	3½	.....
Miles main track already narrow gaged	0	3.55	3.0	2.14	5.34	14.03
Miles side track already narrow gaged	1.50	9.23	10.92	5.55	2.61	29.81
Side tracks completed a. m.	Noon	....	9 15	9.10	10.50	.....
Left broad gage, miles	....	....	....	0.95	....	0.95
Distribution of gangs:						
Men pulling spikes.	5	6	6	6	5	.....
" lining	7	6	6	6	6	.....
" driving stubs.	1	1	1	1	1	.....
" driving spikes.	11	12	10	9	10	.....
" foremen	2	2	2	2	2	.....

A change of gage on almost the entire system of the Southern lines then existing was made on May 31 and June 1, 1886, narrowing it from the old Southern gage of 5 ft. to the Northern standard of 4 ft. 8½ ins. in order to facilitate through traffic. The change made at this time involved 13,000 miles of main track, 1,500 miles of side track, 1,800 locomotives and 45,000 passenger and freight cars. The men worked in gangs of 24 to 26, and averaged 5 miles of track (including switches), in 5 hours 10 mins. On May 30, 1886, the Louisville & Nashville R. R. made the same change on 1,593 miles of main track and 213 miles of side track. The number of men averaged 4 men per mile of main and side track, and 5 men per mile in the terminal yards, or 8,763 men for the entire work. In 1885, the Mobile & Ohio R. R. changed 527 miles in less than 12 hours. There were also 47 engines and 1,666 cars changed. The cost was about $28 per mile of track, or $49.95 per mile, including the change to rolling stock. In all these cases the work was very different to that recently done in England, and above described, as the change was only 3½ ins., except 1 ft. 3½ ins. on the Atlantic & Great Western, and it was much lighter work to draw spikes, shift rails and respike, than to shift a heavy rail and longitudinal bodily 2 ft. 3½ ins. in the ballast. In some cases one, and in other cases both rails were moved in, and the inside spikes for the new gage were generally partly driven before the time of making the change. Besides this, there was no interlocking gear of switches and signals to be altered. The enormous amount of money spent both in this country and England to secure a uniform gage for the prompt and economical handling of traffic shows the extreme disadvantage of a break of gage, and has in this country put a final quietus on the narrow gage idea which was so popular at one time; but it is still alive in some places, including Australia, as shown in our issue of Aug. 4.

THE CHICAGO DRAINAGE QUESTION.

Mr. Benezette Williams has lately submitted the following earnest plea for a 600,000, instead of a 300,000 cu. ft. per min. channel, in which he plainly advances very strong arguments, which we fear may not be effective:

The law requires the larger channel and provides that the main drainage channel shall exceed a capacity of 300,000 cu. ft. of water per minute on any one of the following three conditions of contingencies arising: If the channel passes through a territory having rocky stratum rising above the grade line of an 18-ft. channel; if the population of the Sanitary District exceeds 1,500,000; if the United States Government should improve the Desplaines and Illinois rivers so as to receive 600,000 cu. ft. of water per minute and hold the Sanitary District harmless from all damages caused by such flow of water.

The sanitary needs of the district require it. The questions most pressing upon the sanitary district are not those to which limitations of the law have been attached, but rather those which rest wholly with the district. As pointed out in my report of June 7 under the head of flood waters, the protection of the city's water supply from sewage pollution is by far the most important phase of the sanitary question, and such protection can not be secured so long as the Chicago River is allowed to flow into the lake. It was also shown that with the utilization of the Desplaines River to its full capacity it will still take a channel of 600,000 ft. capacity per minute to control the combined flood waters of that river and of the Chicago River and its branches, which was shown to be at times as much as 1,100,000 cu. ft. per minute. Since that report was submitted this maximum has been reached, viz., on June 24 of this year.

There are two feasible ways of preventing an outflow of the Chicago River: One is to provide sufficient capacity in the Desplaines valley, from Summit down, for the flood discharge of the upper Desplaines, plus that of the Chicago River basin, and another of the North Branch to the lake through the Skokie cut-off or its equivalent, and to provide for the remainder through the valley below Summit. As stated in the June 7 report the first method is probably as safe as the second and decidedly a cheaper one.

I consider, then, that without regard to legal requirements or constructive advantage, but on local sanitary grounds alone, a channel of 600,000 cu. ft. capacity per minute should be excavated to Summit, joining with the one of equal capacity now under contract from Willow Springs to Lockport.

The constructive features make it desirable. Rock is encountered both at Willow Springs and Summit in an aggregate distance of 10,000 ft. It will cost from three to four times as much to excavate it "wet" as it will to excavate it dry, and the same is true of the excavation of glacial drift. The difference in cost between the 600,000 cu. ft. channel and the 300,000 ft. one, using the same prices per unit of quantity, is estimated at $1,043,000, there being approximately 3,575,000 cu. yds. more of glacial drift and 150,000 cu. yds. more of rock to remove for the large channel than for the small one.

PETROLEUM FUEL FOR LOCOMOTIVES.

The use of petroleum fuel for locomotives has been introduced with decided practical success in some countries, and has been experimented with in this country with perfectly satisfactory results so far as the mere burning of the fuel is concerned. One of the locomotives of the Pike's Peak rack railway (Abt system), in Colorado, has been fitted to burn oil. It is quite easy to fit locomotives to burn petroleum, and it has more than once been claimed that this fuel will eventually supersede coal in this country, but, as we pointed out in our issue of April 26, 1890, while it has been proved easy to use, and efficient in performance, it cannot come into any extended use here, for the reason that on the Pennsylvania R. R. alone the consumption would be nearly half the total oil production of the United States. There are, however, evidences of extensive deposits of oil in the northwest of Canada, north and west of Manitoba, and if these should prove as rich as alleged it is not impossible that liquid fuel may yet be somewhat extensively used for locomotive purposes. It has been alleged that the Standard Oil Co. has its eye on these new sources of supply, and if so we may possibly soon hear more about them.

Petroleum fuel for locomotives has been for several years used with satisfactory results in Russia, mainly in the southern part of the country, where coal is scarce and petroleum plentiful. It is extensively used for the simple and compound locomotives of the Grazi-Tsaritsin Railway, in South Russia, which were designed by Mr. Thomas Urquhart, Locomotive Superintendent, and described in our issue of Jan. 14, 1890. Further particulars of fuel consumption, train loads, etc., of these engines were given in our issue of Jan. 2, 1892. Mr. Urquhart, in a letter published in our issue of April 26, 1890, stated that the mean results of a year's working of 15 of these locomotives showed a saving of 18% in liquid fuel for the compound engines as compared with simple engines burning the same fuel. The liquid fuel has certain advantages over coal, one of which is in the ease of firing and the steadiness of the steam pressure, but the supply is so much less than the demand would be if generally adopted, that it is not likely to be used except under special conditions. In certain places, however, such as parts of Russia and South America, where coal is very expensive, oil fuel may be used with advantage. In England it is used to a limited extent on the Great Eastern Ry. and Lancashire & Yorkshire Ry. (Eng. News, March 14 and 28, 1891); in Peru it has been successfully introduced (Eng. News, Sept. 26, 1891), and in the Argentine Republic it is also being introduced, using th oil product of that country in preference to imported coal from motives of economy, as noted in our issue of May 19, 1892. The system adopted in the Argentine is that invented by Mr. James Holden, Locomotive Superintendent of the Great Eastern Ry., of England, and extensively applied to stationary, steamship and locomotive boilers. In our issue of Feb. 2, 1889, we gave details of tests conducted by a board of United States naval engineers to ascertain the applicability of liquid fuel to locomotive boilers, with results that were in general satisfactory, particularly as the apparatus tried could be fitted without interfering with the arrangements for burning coal, as is also the case with the Holden system. Oil fuel has also been tried on locomotives in India, but the supply from the wells in that country is said to have been very limited, and to have failed very soon. The following is an abstract of an article in the "Mexican Financier," giving particulars of the use of oil fuel on the Oroya Ry., of Peru. It is stated that several of the locomotives are already in service on this road, and that it has been definitely decided to adopt this fuel instead of coal. It is also said that the same decision has been arrived at by the Mollendo, Arequipa & Puno Ry., of Peru, and that the necessary changes are now being made to the engines on that road.

Mr. Herbert Tweddle, Jr., resident manager of the London & Pacific Petroleum Co., when in Lima in March, 1890, inaugurated these trials by altering the first locomotive of the Oroya, Ry., for burning "fuel-oil." This fuel oil is not crude petroleum, but is a residuum oil with a fire test of about 300° F. On April 30, 1890, the first regular passenger train in South America pulled by an oil-burning locomotive was hauled up to Verrugas, 5,800 ft. above sea level, arriving on schedule time. From this time until September, when the new fuel was definitely approved of, an engine ran regularly on the mountain service without a breakdown. In service with it was run a sister locomotive burning coal. Running for five months alternately, pulling equal trains over exactly the same ground, these locomotive trials furnish the best competitive tests of practical oil and coal burning on a railway. Engine No. 1 ran with coal, engine No. 15 with fuel-oil. Both engines were exactly alike in other respects. They were built by the Rogers Locomotive Works, of Paterson, N. J., and were of the mogul type, with driving wheels 47 ins. diameter, and cylinders, 18 × 24 ins. Total weight

of engine, 38 tons; tender, 28 tons. Regular train, 5 cars; average weight of car, 18 tons gross. Total weight of train, including tender, 118 tons. Eight and ten cars are sometimes taken as far as Chosica, where the grades of 3 and 4% begin.

The present terminus of the Oroya Ry. is Chicla, 12,218 ft. above the sea, and distant from Callao 80 miles. From Chicla to the summit tunnel is about 20 miles. The summit tunnel is situated at 15,720 ft. above sea level. This is by far the highest railway mountain pass in the world. The grades and distances as far as Verrugas are as follows:

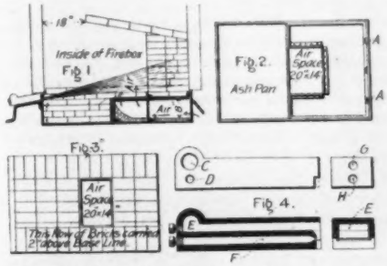
Stations.	Distance from Callao. Miles.	Height above sea level. Ft.	Av. grade. Percent.
Callao	0	....	...
Lima	8½	448	1.00
Santa Clara	18½	1,312	1.66
Chosica	33½	2,832	1.88
San Bartolome	47	4,919	3.00
Verrugas Bridge	51¾	5,840	3.70

Among the heavy grades as far as Verrugas may be mentioned, between Chosica and San Bartolome, one grade of 4.2%; another of 4% combined with a curve of 900 ft. radius; and again two miles before San Bartolome, a grade of 3.92% combined with a curve of 370 ft. radius.

As to the behavior of the No. 15 (with oil fuel), on these heavy grades, the steam gage always recorded from 135 lbs. to 140 lbs., never falling below 135 lbs., and as a rule the hand stood immovable at 140 lbs. Although the safety valve would blow off at 142 lbs., so admirably was the fire at all times under control that it very rarely blew off. On all the grades up to 3% no smoke whatever showed from the smokestack. On the 4% grades a slight hazy smoke would show at times.

The average consumption of coal for the month was 79.30 lbs. per train mile. The average consumption of fuel oil per train mile was 38.55 lbs., or slightly less than 50% of the amount of coal used. The explanation of this lies in the regular feeding of fuel where a liquid is used, as compared with the irregular and wasteful coal stoking. Again, on the heavy grades of the Oroya Ry., the sharp, strong exhaust carries a large percentage of the smaller coal out of the smokestack unconsumed. In the tunnels the oil proves a great boon to passengers, doing away with the former choking smoke, while at all times windows may be kept wide open with no danger from sparks or redhot pieces of coal flying in.

The apparatus used on the Oroya Ry. is shown in Figs. 1 to 4, and, as will be seen, no alterations are made in the firebox, while but a few additions are



Oil Burning Apparatus for Locomotives; Oroya Railway, Peru.

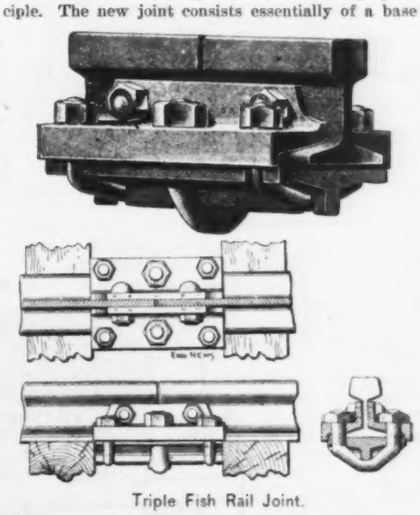
put to the regular ashpan. Fig. 1 shows the alterations made; the back damper is completely closed, a large damper 32×9 ins. with about 2 sq. ft. opening being arranged in front. Above the supports A goes the plate B, Fig. 2, with an air opening 20×14 ins. This plate supports the firebrick at the back of the firebox which receives the vaporized oil. Fig. 3 shows a section of the brick arrangement. Fig. 1 shows a section through the firebox and ashpan, with burner in position. In Fig. 4, representing the burner, the elevation shows it tapped at C for a 1¼-in. oil pipe, and at D for a ½-in. steam pipe. In the longitudinal section through center of burner; E is the oil passage and F the steam passage; both these passages are 3 ins. by ¾-in. The small cuts represent the back and front ends of the burner. The oil coming through the passage E falls directly on the steam shooting through the narrow slit at the end of the passage F and is completely vaporized. With this burner the bricks do not serve in any way for breaking up the oil, but merely as a white-hot retort in which air and vaporized oil are mixed in the proper proportions. The supply of air is regulated by the front damper, the supply of oil by a gate valve worked by a wheel under the fireman's hand in the cab. The steam is never touched except when the engine is lying up for any length of time at a station. With fuel and air under such exact control, it is not strange that perfect combustion with no smoke is obtained. The holes G and H at the back of the burner are closed with plugs. By unscrewing these the burner can be quickly cleaned without removing; this, however, is rarely found necessary, the burner as a rule keeping perfectly clean for an indefinite period.

The burner is cast in one piece and finished by hand at a total cost of about $12.50. As this burner is of one piece without any movable parts, it is not liable to get out of order. The burner used on the Grazi-Tsaritzin Ry., in Russia, is excellent of its kind, but composed as it is of over 20 different pieces, all of which have to be accurately finished and fitted, it is a complicated thing to make and a costly article. It was only after trying some score of burners that Mr. Tweddle and his colleague hit off the simple idea now embodied in the Oroya burner. As an easy burner to make, as a quick steam maker, and from an economical stand point, both in fuel used and first cost of burner, it leaves little to be desired. The length of this burner is entirely arbitrary. Owing to an axle immediately back of the firebox on the locomotives on the Peruvian railways, it is made 15 ins. long so that the pipe connections may be handily reached at all times. The width of burner is made to suit the quantity of fuel to be sprayed in an hour. On the Oroya Ry., on the 4% grades, as much as 220 lbs. of coal are burned per mile or 120 lbs. of oil. To perfectly spray such a large flow of oil a certain width of steam and oil passage is necessary. Sizes varying from 1½-in. up to 4½ ins. wide were tried, the burner finally decided on having an oil passage 3 ins. wide and a steam passage 3¼-ins. wide. The aperture of the oil passage is 3 ins. by ¾-in.; the steam aperture is 3¼ ins. by 1-40 in. Around the oil opening runs a projecting hood as shown in Fig. 4, which prevents any oil from leaking when rounding sharp curves.

Steam from another locomotive is used in getting up steam; a pressure of 100 lbs., raised from cold water has been shown on the steam gage in 25 minutes, but an hour is generally taken so as not to strain the boiler. Wood can be used for getting up steam if necessary. The No. 15, using oil fuel, after running six months showed no signs of leaking in the firebox, nor any signs of straining. Only 150 bricks are used for the whole brick work, including the arch. This brick work will last from six to eight months.

THE "TRIPLE FISH" RAIL JOINT.

This joint is the invention of Mr. Clark Fisher, inventor of the well known Fisher bridge joint for rails, and is designed to meet the objections sometimes raised to the use of the bridge plate bearing on the ties, the two joint ties having to be sunk lower in the ballast than the intermediate ties in order to allow for the thickness of the bridge plate. On the other hand, it necessarily sacrifices the bridge principle. The new joint consists essentially of a base



Triple Fish Rail Joint.

plate and two short heavy angle bars, the flanges of the latter extending over the edges of the base plate. Three U-bolts hold the splice bars and base plate together and against the base of the rail, and the corners of the rail flanges are cut off to form a notch to receive the middle bolt and thus prevent creeping of the track. Two ordinary track bolts hold the splice bars to the web of the rail. The base plate is short and rests between the two joint ties which are placed close against it. By this joint a bottom support is given to the rail ends, and the rails are firmly held down upon this support, thus insuring good surface, while all of the five bolts hold the rails in line. The joint was patented in December, 1891, and is manufactured by the Fisher Rail Joint Works, Trenton, N. J.

A PRACTICAL CONSIDERATION OF COMPRESSED AIR.*

The whole question of compressed air economy is based upon: (1), economy of production; (2), economy of use. Transmission calls for but little consideration. This statement will doubtless surprise many who look upon the losses suffered in the use of compressed air as due largely to transmission, and no better evidence is needed of the obscurity of the science, even among engineers, than this fact. There is not a properly designed compressed air installation in operation to-day that loses over 5% by transmission alone. The question is altogether one of the size of pipe; and if the pipe is large enough, the friction loss is a small item. It is undoubtedly true that there are places where a conduit has been laid for a certain volume of air, and where the supply has been increased without increasing the size of the conduit, the result of this being that more air is forced through the pipe than its sectional diameter will admit economically; hence the velocity of flow is increased, and as the friction is in direct proportion to the velocity, the loss of power is also increased. The largest compressed air power plant in America is that at the Chapin Mines in Michigan, where power is generated at Quinnesec Falls, and transmitted three miles. This is not an economical plant, but the loss of pressure as shown by the gage is only 2 lbs., and this is the loss which may be laid strictly to transmission. I recently visited the Jeddo Tunnel, near Hazelton, Pa., where compressed air at 60 lbs. pressure is conveyed 10,800 ft. They told me that they had tried the gage on both ends of the line, and had found no difference whatever in pressure, but that the gage had been sent to the shops for repairs as they were convinced that "something was wrong." The result was not changed when the gage had been "repaired," and it was evident that this apparently perfect economy of transmission was due to the fact, that a large pipe (5¾ ins. in diameter) was used to convey so small a volume of air that the velocity in the pipes produced so small a friction loss that it could not be recorded on the gage.

A question commonly asked is: How much power is lost in using compressed air? I usually reply, 50%, because a proper qualification of the question will result in figures in one case below and the other above 50%. If compressed air is produced by the best modern air compressor, and used by the best modern engine immediately at the compressor, the loss is only that which is suffered when using any like engine, and is confined in its greatest extent to the question of engine friction, and is only to a small degree influenced by shrinkage of volume through radiation, clearance loss, leakage, etc. In such cases the loss varies between 10% and 25%, but such cases are rare, because it would obviously be more economical to use the steam direct.

The usual conditions of compressed air use are those where the air engine is situated from 1,000 ft. to several miles from the compressor. In most cases the distance is so great that the compressed air enters the engine at a temperature equal to that at which it entered the compressor. Were it possible to produce compressed air isothermally, that is without increase of temperature during compression, the service would be economical even at low temperatures; but isothermal compression has never been realized, and the heat produced during compression (which is the exact equivalent of the power applied) is suffered to increase the pressure and hence to increase the resistance to compression, without a relative increase of volume. Hot air under pressure is discharged into a receiver, and the gage indicates a pressure of (say) 60 lbs., which is equal to that recorded by the gage 10,000 ft. away, yet it is a false indication as affecting the question of power, because every cubic foot of 60-lb. air at the compressor is less in weight than an equal volume of equal pressure air at the engine, in exact proportion to the difference in temperature. The result of this is that an air engine which uses (say) 100 cu. ft. of 60-lb. air per minute at the temperature of the surrounding atmosphere, really uses about 150 cu. ft. of 60-lb. air at the receiver temperature. All this is very important in looking for a remedy for compressed air losses, because it points to the influence of heat upon air, and the importance of reheating compressed air.

The loss of power in common practice, where compressed air is used to drive machinery in mines and tunnels, is about 70%. I refer to cases where common American air compressors are used, and where the air is transmitted far enough to lose its heat of compression and is exhausted without reheating. In the best practice, with the best air compressors, and without reheating, the loss is about 60%.

These losses may be reduced to a point as low as 20% by combining the best systems of reheating with the best air compressors. In France, England and Germany

* From a lecture before the Franklin Institute by Wm. L. Saunders, M. Am. Soc. C. E., Secretary Ingersoll-Sergeant Drill Co.

there have been erected during recent years large compressed air installations. In Paris about 25,000 HP. is transmitted over the city and is used to drive engines and for many other purposes. With a less efficient production than our American system, they have advanced beyond us in the use of compressed air. Reheating has been put into general use, while here in America the improvements have been more conspicuous in the air compressor. Prof. Kennedy, whose elaborate report (**) on the Paris Plant is accepted as an authority, uses the following words:

Summarizing now the whole matter as regards efficiency, it may be said that the result of my detailed investigations is to show that the compressed air transmission system in Paris is now being carried on, on a

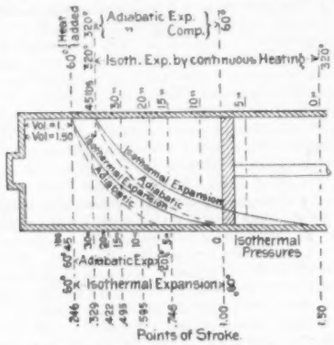


Fig. 1. Diagram Illustrating Changes of Pressure and Temperature in Air Compression.

large commercial scale, in such a fashion that a small motor four miles away from the central station can indicate in round numbers 10 HP., for 20 HP. at the station itself, allowing for the value of the coke used in heating the air.

We may reasonably expect to add to this 50% efficiency attained in Paris by an installation which combines the American compound condensing Corliss air compressor with an efficient and economical reheating apparatus and Corliss or other economical engines.

The whole science of the production and use of compressed air can be best understood by a simple practical illustration: Fig. 1 is an open cylinder which may be made to illustrate at the same time the air compressor and the air engine. The piston at the point shown is supposed to confine a volume of free air in the cylinder and at a temperature of 60°. Let it be pressed down until it reaches the point indicated by 45 lbs. at the left, and the pressure will follow the dotted line marked "Adiabatic." This is, of course, assuming that the heat, which is invariably produced by compression, is suffered to remain in the air and to influence the pressure. We have here a confined volume of compressed airat a pressure of 45 lbs. and a temperature of 320°. Let there be no absorption of heat and the piston if released will return to the starting point, the pressure following exactly the line indicated during compression and the temperature returning to 60°. In such a case we assume, of course, that the piston is frictionless. This points to the fact that compressed air is a perfect spring, and that the heat of compression when utilized can be made to return its full value of energy.

An air compressor, in spite of its cooling apparatus, usually furnishes compressed air at pressures following closely the adiabatic line, so that the illustration applies to a typical case so far as the compression is concerned. This subject of adiabatic compression has been fully referred to, and the difficulties which have stood in the way of isothermal compression have been pointed out in a pamphlet written by me about a year ago. ***

We have now seen that the heat of compression is not such a serious thing provided it can be utilized. The hot compressed air confined below the piston at the 45-lb. point, if transferred through pipes or otherwise to an air engine and maintained hot, will do as much work as we have just seen is possible when applied to the air compressor itself in driving the piston back to the starting point. To convey this air some distance hot, is a difficult matter; for compressed air, though very slow in taking up heat, has so low a specific heat that it parts with its temperature rapidly.

For this reason, we cannot advise saving the heat during transmission by covering the pipe, so that we now suffer the loss of heat during transmission to go on, depending upon restoring the heat immediately at the air engine. Now this reheating is not, as some may suppose, means by which the gain is only equal to the expenditure. Air is almost a perfect gas, and the application of heat is a direct transfer of energy to a substance which, through its elasticity, is capable of giving a full return. We burn a pound of coal under the boiler, and get only about 10% back in power, because of the large loss in the stack, the loss in the exhaust, the difficulties in the way of utilizing the latent heat, etc.; but when we heat compressed air the thermal energy in the coal is stored in the air, and we are only limited in our efforts to utilize all of it by the reduction of pressure which takes place more rapidly than the reduction of temperature, and hence a warm exhaust. Radiation of heat between reheater and engine is also a source of some loss.

Returning to Fig. 1, let us imagine that the piston has been stopped at the 45-lb. point, and that this air, which, as we have seen, has a temperature of 320°, is transferred into a receiver and used at a point a mile away. The temperature will now be reduced to 60°, and if the system is well designed we have nearly 45 lbs. pressure on the other end of the line, so that the volume of air will be reduced in size corresponding with the space underneath the lowest horizontal dotted line in the figure. This is marked "Volume I." Is is now used without reheating, to do the work in an engine, and the line of reduction in pressure will now follow the lower dotted line marked "Adiabatic" until it reaches the point marked—201°, which will represent the temperature of the air when exhausted at atmospheric pressure. We now see that instead of getting back to the starting point, the piston has only power enough to return about half-way. If, on the other hand, heat were applied during expansion, the pressure would follow the line marked "Isothermal Expansion" and the piston would return to the starting point.

Another case is shown by the figure in which the air is compressed adiabatically to 45 lbs., and heat enough is applied during expansion to maintain the temperature at 320°, until the air is exhausted at atmospheric pressure. This illustrates the possibility of obtaining more power out of a given volume of air after compression than was expended at the compressor.

Mr. Saunders then described systems of air reheating, and gave an account of some of the newest and most important inventions covering the utilization of compressed air. There are two possible systems of reheating. In the first the air is reheated in the cylinder of the engine after cut-off. This has never been made practically applicable. The second system is that in common use, in which the heating is done before the air reaches the engine. This saves volume of the air only. It does not increase the pressure, except in a minute degree, as it reduces the rate of flow through the mains, and so reduces the loss of pressure due to the friction of the pipe. In the ordinary application of this system the air is led through pipe coils, which are heated by a stove or furnace. Mr. Saunders, however, has experimented with some success on the possibility of burning the fuel directly in the compressed air chamber, and so adding the volume of the products of combustion to that of the air in the pipe. In one experiment a miner's lamp was placed in a chamber, attached to a 4-in. pipe conveying air to the drills; oil was supplied to the lamp by a hand pump. The limit to successful reheating lies in the fact that air engines cannot work to advantage at temperatures over 350°.

The efficiency of the common system of reheating is shown by the results obtained with the Popp system in Paris. Air is admitted to the reheater at about 83°, and passes to the engine at about 315°, thus being increased in volume about 42%. The air used in Paris is about 11 cu. ft. of free air per minute per I. HP. The ordinary practice in America with cold air is from 15 to 25 cu. ft. per minute per I. HP. When the Paris engines were worked without reheating the air, consumption was increased to about 15 cu. ft. per I. HP. per minute. The amount of fuel consumed during reheating is trifling. With the reheaters commonly employed, in Paris it amounts to 1 to 2 cts. per HP. per day.

Another method for reheating the air supply is to place an electric heater in the supply pipe. A great advantage of this for use in fiery mines is that it does not require flame or combustion of any sort.

For mining work, Mr. Saunders says that electric power is especially adapted, since it is applicable to so many different purposes, lighting, hauling,

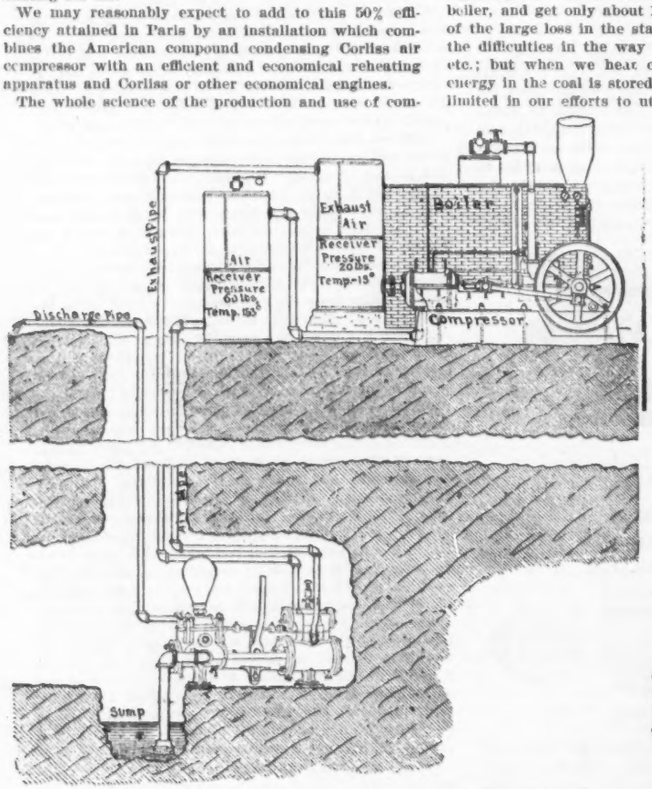


FIG. 2. DIAGRAM OF COMPRESSED AIR PLANT ARRANGED TO UTILIZE THE POWER OF EXHAUST.

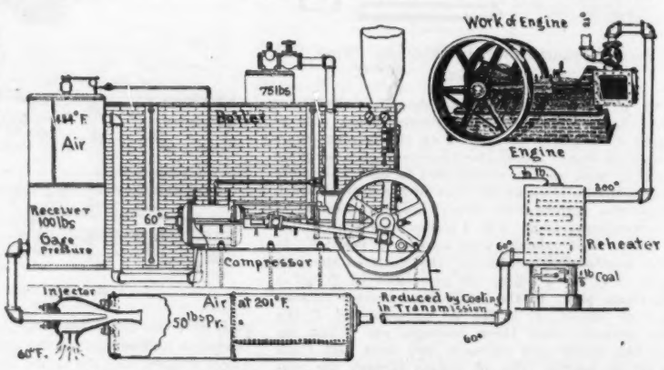


FIG. 3. PROPOSED SYSTEM OF UTILIZING HEAT IN COMPRESSED AIR BY USE OF INJECTORS.

** See Eng. News, Dec. 14, 28, 1889.

*** "Compressed Air Production," published Eng. News Pub. Co.

pumping, hoisting, etc. To work pneumatic rock drills by electric power with greatest economy, Mr. Saunders proposes to set up an electric air compressor in the mine, driving it by solenoids, although at the present stage of electric developments an ordinary motor belted to the fly wheel seems to us more practicable. Hot compressed air would be produced by this plant, and would be transmitted through a felted pipe, and used hot at the drill. Concerning electric reciprocating rock drills, he says:

Electric rock drills are subject to many costly limitations. Thus far they have not been successful, and it is a serious question whether or not it is possible to accomplish the drilling of rock by the percussive principle (which is the only true one), by an electric engine which will be equal in weight, in price and efficiency to an air engine. The weight of a rock drill is one of its most conspicuous limitations, and from every basis of theory and practice a compressed air percussive engine will weigh less than half that of an electric one of the same power. An electric drill is made of copper, which cannot compete in price with iron, and the durability of the apparatus is apparently in favor of the air drill.

In conclusion the author describes two ingenious schemes for economizing power in the use of compressed air; the first one so simple that it will be surprising if someone has not already put it into use.

Fig. 2 illustrates what may be called an endless chain of pneumatic power. An air compressor draws its supply of air from a receiver in which there is a pressure of 20 lbs. The air is compressed to 60 lbs., and is carried down a shaft and used to drive a pump. The exhaust of the pump is returned to the initial air receiver; and thus the same air is used over and over again, all of the exhaust pressure being utilized. As pumps usually exhaust at pressures from 20 to 50 lbs., a large saving is effected in this alone.

When starting, it is simply necessary to open a valve on the initial air receiver until a pressure of 60 lbs. has been reached in the secondary receiver; the valve is now closed and the work goes on. The economy of this system is apparent. The heat of compression is converted into work in the pump.

The economic advantages of a very low initial temperature in air compression has been fully set forth in a diagram which I have published in "Compressed Air Production," and a power diagram of such a system as this indicates several other economical points, notably the admission of compressed air instead of free air through the inlet valves, which serves to reduce the heat loss during compression and to equalize the resistance strains in the engine.

Fig. 3 illustrates in contracted form a complete pneumatic installation comprising boiler, air compressor, air receiver, air injector, supplementary air receiver, pipe for transmission, reheater and air engine. The reheater and air engine should be considered as situated from 1,000 ft. to several miles from the compressor.

It will be observed that atmospheric air is drawn in the piston inlet tube of the compressor at 60° temperature. It is compressed adiabatically; that is, without any provision for cooling during compression, and in this way all of the power expended in the steam cylinder is converted into heat, which remains as power in the air. Now, we have seen that, if all of this heat can be utilized, it will return 100% in power, less such small items as friction, leakage, etc., and the purpose of this sketch is to call attention to a means by which at least a large part of this heat may be saved, and not wasted by radiation into the atmosphere or by absorption in water. An air injector is located between two air receivers, and the highly compressed or the highly heated air from the first receiver is admitted through the nozzle of this injector, and is thus converted into high velocity inducing free air from the atmosphere, and discharging an increased volume at a reduced pressure and temperature into a secondary receiver. For the sake of illustration, the pressure in the first receiver is taken at 100 lbs. and is reduced to 50 lbs.

This air injector has been tried with success, though the experiments have not gone far enough to determine to what extent it will effect a saving in the production of pneumatic power. It has been found that with a pressure of 80 lbs. in the first receiver, the injector will work, discharging and inducing free air into a second receiver in which is maintained a pressure of 60 lbs. This difference of pressure may obviously be modified by the shape of the nozzle, sizes of pipes, etc., and it is probable that the injector may be made to work at a difference between two pressures of only 10 lbs.

The velocity with which compressed air is discharged through a nozzle does not differ materially at pressures of 15 lbs. and over. The actual velocity with which compressed air at five atmospheres is discharged through a short pipe is 658 ft. per second, and at ten atmospheres the velocity is 649 ft. per second. This is because high pressure air is more dense than air at low pressure, and just in proportion as the density increases does its resistance to movement increase. This is one of the limitations to the pneumatic dynamite gun. They started on about 500 lbs. pressure and fell short of the mark. It appeared that it was only necessary to increase the pressure to increase the range, but the limitations were soon discovered.

With air discharged through an injector nozzle at a velocity of 650 ft. per second, it is easy to understand that free air will be induced and discharged with it into a secondary receiver.

This is not a case where something is sought from nothing. The hot compressed air is converted into high velocity and thus the heat of compression is utilized. Were it not utilized in this way it would simply be discharged into the atmosphere by radiation, which is the usual practice in long-distance transmission in America.

RAILWAY EARNINGS FOR SIX MONTHS.

Railway earnings for the first six months of 1892 have been decidedly irregular, but on the whole quite satisfactory, considering the many adverse factors with which the railway managers have had to contend. From an article in a recent number of the "Financial Chronicle" giving detailed statements of the earnings of a large number of railways in the United States for the first half of 1892, as compared with the same period of 1891, we abstract the following figures, adding thereto tables of percentages and changing their arrangement somewhat to facilitate comparison. These figures, considering the promptness with which they are published, are quite comprehensive, and afford a very fair index of the prosperity of the railway system of the country. They cover 190 railways operating 124,226 miles of road, or about 72.8% of the total railway mileage of the country. It is to be noted, however, that a few Canadian and Mexican roads are included in this total, but their aggregate earnings are comparatively so small as to affect the general results but little.

It will be seen from Table 1 that the results for the half year are more satisfactory for gross earnings than they are for net earnings, showing that there has been a considerable augmentation of operating expenses. This is due in part to quite extensive outlays for damages caused by the rainy weather and floods and also to the more liberal policy of expenditure attendant upon more satisfactory earnings, and upon the prospect of a very large increase of passenger traffic and earnings in 1893. The increase in operating expenses has been sufficient to bring about decreases in net earnings in January and again in April and May; these being months in which bad weather was most prevalent.

As the floods and bad weather were confined largely to certain sections of the country only, while in other sections the conditions were strikingly favorable, considerable irregularity would be expected in its earnings, and also the more liberal policy of expenditure attendant upon more satisfactory earnings, and upon the prospect of a very large increase of passenger traffic and earnings in 1893. The increase in operating expenses has been sufficient to bring about decreases in net earnings in January and again in April and May; these being months in which bad weather was most prevalent.

As the floods and bad weather were confined largely to certain sections of the country only, while in other sections the conditions were strikingly favorable, considerable irregularity would be expected in the earnings of different groups of roads. This will be seen to be the case from Table 2. Both the Northwestern and Southwestern groups of roads are distinguished by strikingly good earnings. These were the sections most favored by the large crops, and consequently heavy grain shipments, and in the Northwest especially a great stimulus has been given to business by the preparations for the World's Columbian Exhibition and the increase in building operations connected with it. Against these increases the Pacific roads show very slight changes, while the Southern roads, though showing an increase in gross earnings, record a decrease in net earnings. Both of these sections have experienced a considerable industrial depression, and in the South the low price of cotton and general collapse of real estate speculations and the various land enterprises has contributed largely to the unfavorable showing of the roads in this group. The trunk lines have a considerable gain in gross, but a slight loss, due largely to increased expenses, in net. The various roads in the Middle and Middle-western groups, which are affected in a considerable degree by the same conditions as the trunk lines, exhibit quite favorable increases in both gross and net earnings. Very favorable results are also shown by the anthracite coal roads.

Considering the various roads separately, it is found that of the total 190 roads, 57 show decreases in gross and 76 decreases in net. Some of the principal changes from last year's figures in both gross and net earnings are shown in Table 3. As would be expected, the grain carrying roads both in the East and in the West are very conspicuous in this list.

Table 1.—Showing Comparative Gross and Net Earnings of Railways for Each Month and for the First Six Months of 1892 and 1891.

Month & No. of Roads.	Gross Earnings. 1892. 1=1,000	1891. 1=1,000	p. c. inc.	Net Earnings. 1892. 1=1,000	1891. 1=1,000	p. c. inc.
Jan. (126)	53,634	52,468	2.18	13,442	14,324	−6.15
Feb. (130)	58,187	50,806	14.58	16,429	13,641	+20.40
Mar. (131)	61,081	55,393	10.27	18,728	16,470	+13.70
Apr. (127)	56,406	53,381	5.67	18,999	16,014	−0.19
May (131)	60,506	58,377	3.65	17,289	18,123	−4.60
June (124)	58,540	54,216	7.98	17,515	17,065	−14.47
6 Mos. (190)	448,515	416,936	7.57	131,071	124,464	+5.31

Table 3.—Showing Principal Changes in Gross and Net Earnings for Six Months of 1892, from Similar Figures for the First Six Months of 1891:

Name of Road.	Gross Earnings. Inc. 1=100	Gross Earnings. Dec. 1=100	Net Earnings. Inc. 1=100	Net Earnings. Dec. 1=100
Bost. & Alb.	3,861	.....	7,255	.....
Fitchburg	2,261	.....	1,727	.....
Maine Cent.	2,744	.....	2,180	.....
Penn.	36,068	.....	428	.....
Phila. & Read.	25,868	.....	6,988	.....
N. Y. C. & H. R.	12,737	.....	.....	4,917
N. Y., L. E. & W'n	10,072	.....	99	.....
Balt. & Ohio	7,756	.....	.....	1,977
C., C., C. & St. L.	4,479	.....	.....	205
L. S. & Mich. So'n	11,581	.....	3,466	.....
Wabash	4,478	.....	....	1,001
Norf. & W'n	3,060	.....	.....	718
L'sv'e & Nashv'e	9,881	.....	626	.....
Georgia	.....	2,090	.....	1,821
Chic., Bur. & Quincy	34,672	.....	6,474	.....
Chicago & No'w'n	21,525	.....	7,927	.....
Chic., Mil. & St. P.	24,226	.....	9,017	.....
Ill. Central	5,548	.....	445	.....
Union Pac.	6,220	.....	7,424	.....
Northern Pac.	.....	4,582	.....	2,136
Southern Pac.	.....	5,139	.....	5,768
Canadian Pac.	7,910	.....	3,679	.....
Missouri Pac.	8,327	.....	1,083	.....
Atch., Top. & S. Fe.	13,372	.....	4,290	.....

Table 2.—Showing by Groups the Gross and Net Earnings and Mileage of Railways Reporting Earnings in the United States for the First Six Months of 1891 and 1892.

Group and No. of roads.	Gross earnings 1892. 1 = 1,000	Gross earnings 1891. 1 = 1,000	Inc. P. C.	Mileage 1892.	Mileage 1891.	Inc. P. C.	Net Earnings 1892. 1 = 1,000	Net Earnings 1891. 1 = 1,000	Inc. or Dec. P. C.
New Eng. (11)	12,187	11,253	8.28	1,920	1,881	2.61	3,900	2,686	+ 45.22
Trunk lines (20)	154,330	144,106	7.10	25,062	24,729	1.35	42,680	42,976	− 0.99
Anthracite coal (12)	38,436	35,117	9.43	3,451	3,384	1.98	11,060	9,959	+ 11.06
Middle States (29)	18,335	17,572	4.29	3,099	3,098	....	6,365	6,138	+ 3.67
Middle Western (30)	20,878	19,462	7.28	8,584	8,572	0.14	5,768	5,289	+ 9.04
Northwestern (17)	55,978	46,215	20.80	21,950	21,798	5.45	17,052	14,205	+ 20.04
Southwestern (16)	42,724	39,841	7.35	18,120	17,840	1.57	11,230	10,068	+ 11.67
Pacific coast (23)	63,991	63,520	0.74	25,269	24,992	1.07	20,983	20,577	+ 1.97
Southern roads (36)	35,917	34,420	4.30	13,372	12,154	10.01	10,206	10,758	− 5.14
Mexican roads (2)	5,787	5,465	5.90	3,021	2,745	10.07	1,884	1,812	+ 3.99
United States (190)	448,515	416,980	7.57	124,226	121,193	2.52	131,071	124,464	5 31

A CHESAPEAKE & DELAWARE SHIP CANAL.

The proposed Chesapeake & Delaware Bay Ship Canal is estimated to cost only $2,358,135, and a company is to be organized to push the enterprise. The present canal connecting the two bays is navigable for vessels drawing 9 ft. of water. It extends across the Maryland peninsula and has a total length of 13¾ miles, the greater part of which is a natural waterway. There are three locks on the canal, each 24 ft. wide and 224 ft. long. The summit level is 9 miles long and 16 ft. above tidewater. For a distance of about three miles on this level the canal passes through hills of sand and clay about 76 ft. high. About 3,500,000 cu. yds. were excavated in building this section. For most of the remaining portion of the canal's length the ground on each side is low and swampy, affording excellent facilities for dumping spoil.

Prof. L. M. Haupt, the projector of the ship canal, proposes to follow the route of the present canal, but he would make it a sea-level canal obstructed only by a tidal lock at the Delaware Bay end. The tide at Baltimore only rises 9 to 18 ins., so that a

tidal lock at the Chesapeake end is not required. He proposes a section 130 ft. wide at the top and 50 ft. at the bottom with a depth of 27 ft. This would require an excavation 43 ft. deep along the summit level of 9 miles, and one 33 ft. deep for the remaining 4½ miles. The cost of the enlargement is roughly estimated as follows: Dredging 10,081,729 cu. yds. at 15 cts., $1,512,259; other expenses, $845,875; total, $2,358,135.

By this canal the water route between Baltimore and Philadelphia would be shortened to 112 miles, against the present trip of 422 miles around Cape Charles. The canal would also shorten considerably the length of the voyage for vessels plying between Baltimore and European ports.

The present canal was completed in 1829, and has a traffic of about 750,000 tons per annum, sufficient to pay interest on 5% bonds amounting to $2,602,950, but making no returns to its stockholders. Mr. Jos. E. Gillingham, of Philadelphia, is the President of the company, and is reported to be strongly in favor of the proposed enlargement.

In 1883 a report on the ship canal project was made by the U. S. Engineers, and the cost for enlarging the present canal to a section 100 ft. wide at bottom and 27 ft. deep with a slope of 1½ to 1 was estimated as follows:

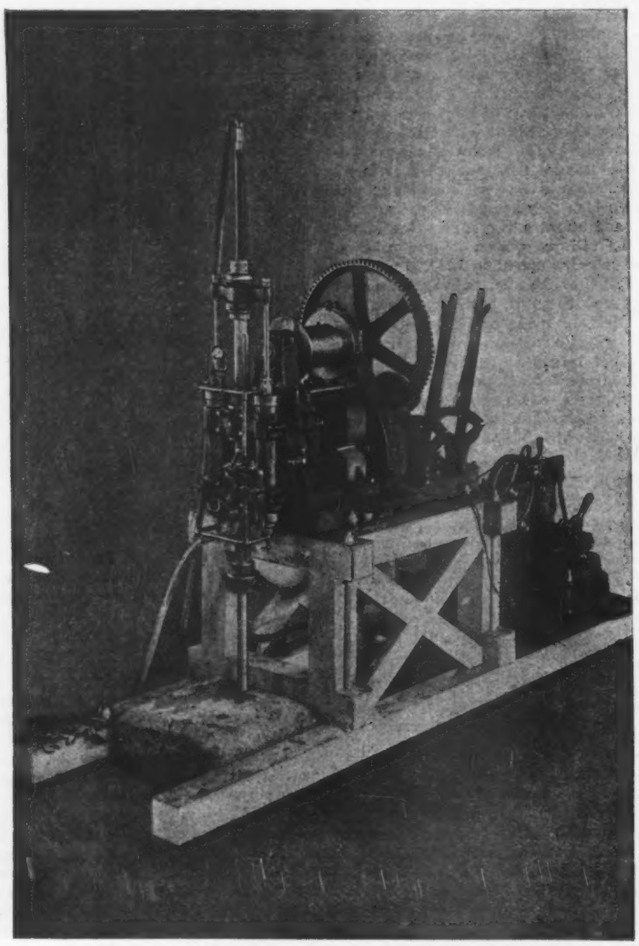
Excavation above high water, 6,951,344 cu. yds., at 20 cts.	$1,390,268
Excavation between high and low water, 2,171,530 cu. yds., at 15 cts.	325,729
Excavation below low water, 12,898,616 cu. yds., at 12½ cts.	1,612,327
Tide lock, bridges, land damages, contingencies	1,027,482
Total	$4,355,806

Prof. Haupt believes that a channel of half the bottom width would cost much less (as above), and would fulfill all requirements for years to come;

A NEW ELECTRIC DIAMOND DRILL.

We illustrate herewith the latest type of diamond drill driven by electric power, which has just been placed on the market by the General Electric Co. The drilling apparatus is mounted on a stout timber frame, on the rear of which is placed an electric pump for supplying water to the drill. This pump will force about 700 gallons per hour against a pressure of 150 lbs. per sq. in. It supplies water to the hydraulic cylinders of the drill as well as to the drill rod.

Valves are set in pipes leading to the pressure cylinder so that any desired pressure may be put upon the drill bit. A valve also controls the supply of water to the drill rod, the pump being able to supply an ample amount to keep the cutting rim of the bit perfectly free and clean. The drill head is arranged with a heavy hinge so that, when uncoupled from the drill rod, it may be swung away from the frame, to allow room for hoisting the drill rods from the hole.



THE GENERAL ELECTRIC CO.'S NEW DIAMOND DRILL.

The most convenient feature of the drill, perhaps, is that the work of hoisting is also accomplished by electric power. A small hoisting drum is mounted on top of the main standards of the frame, and the movement of a lever locks a clutch which connects the drum gearing to the electric motor. By the aid of a block and fall the machine will then hoist out its own drill rods.

Tests of the power of these drills were recently made at the Schenectady works of the General Electric Co. The following were the rates of boring in solid granite with various pressures on the hydraulic pistons:

Pressure on pistons, lbs. per sq. in.	Time required to bore 12 ins., minutes.
120	3
75	6
35	16

Of course these experimental records were made with a short barrel coupled directly to the drill head, and would be somewhat diminished with the machine working under ordinary service conditions.

State road conventions were held last week at Des Moines, Ia., and Chillicothe, Mo. At the Iowa convention delegates were present from 130 cities and towns well distributed throughout the state and steps were taken to organize a permanent association. Resolutions were adopted at Des Moines favoring the consolidation of road districts within townships, the levying of county road fund taxes for improvements to county roads, and the abolition of the old system of paying road taxes in labor.

The Missouri convention was also well attended. A report was adopted from a Committee on Legislation and Means. This report recommended that the roads of the state be divided into three classes, as follows: (1) Macadam, gravel or turnpike. (2) Well graded and thoroughly drained dirt roads. (3) Ordinary ditched or graded roads. The roads of the first class to be built in sections not less than one mile long upon petition of a majority of abutting property owners, not less than 25% of their cost to be paid by the abutters or by voluntary subscription. Roads of the second and third classes to be paid for by the county. The committee recommended the cost of roads of the first and second classes be met by the proceeds from "dram shop licenses," by the poll tax already authorized, and by a general tax of 50 cts. per $100; and that the cost of roads of the first class, above the amount assessed on abutting property, be met by a special tax, the amount to be determined by votes of the people affected. Prof. Hiram Phillips, of St. Louis, read a paper on vitrified brick as a material for street and highway construction. In the discussion of this paper it was generally held that for country roads brick is altogether impracticable, owing to its cost.

Several implements used in road making were exhibited at Chillicothe and in order to show the advantages of wide over narrow wagon tires, experiments were made with Studebaker wagons having tires of various widths. The weight of each wagon and its load was approximately 4,000 lbs. Dynamometers were used and the result of trials on soft earth and grass sod were as follows for the various widths of tires, the nature of the units of comparison not bein stated:

Width of tire, ins.	Units of Tractice Force Required. Soft earth.	Grass sod.
1½	663½	347½
3	473	255
4	461	242

The narrow tires, of course, cut up the roads, while the wide tires tended to compress and improve them.

PERSONALS.

Mr. W. R. Geeting has opened an office at 70 La Salle St., Chicago, to carry on a civil engineering and surveying practice.

Mr. W. H. Rushforth, inventor of the Rushforth feed water heater, for utilizing the heat in locomotive smoke boxes, died at Rutherford, N. J., Aug. 20.

Mr. J. W. Fox has been appointed Assistant City Engineer, in charge of sewer construction, under Mr. Hoff, City Engineer, at Newark, N. J.

Mr. John H. Sample has been appointed Chief Engineer and Superintendent of the Pittsburg, Akron & Western R. R., with headquarters at Akron, O.

Mr. Frank C. Osborn has opened an office as a civil engineer in the Arcade, Cleveland, O., making a specialty of bridge and structural work. He retains his position as consulting engineer for the King Iron Bridge & Mfg. Co., of Cleveland.

Mr. W. T. Baker has resigned his position as President of the World's Columbian Exposition on account of ill health. Mr. Baker is now in Europe, where he will remain for some months. Mr. H. N. Higinbotham, First Vice-President, has been elected President.

Mr. Emmons Raymond, of Cambridge, Mass., a railway builder and manager, died Aug. 18, at the age of 86. He was one of the first directors of the Boston, Concord & Montreal R. R., was President of the Connecticut & Passumpsic R. R. from 1870 to 1887, and was one of the original subscribers to the stock of the Atchison, Topeka & Santa Fe R. R.

Mr. Richard Relf, of St. Paul, Minn., has been appointed engineer in the office of the United States Commissioner of Railroads, vice Mr. Thomas Hassard, resigned. Mr. Relf has been for several years Assistant Engineer in the office of the Chief Engineer of the Northern Pacific R. R., and made the first survey for that road from Lake Superior to the Red River.

Mr. Edward F. Mann, Superintendent of the Concord & Montreal R. R., died at Concord, N. H., Aug. 19, at the age of 47. He was a native of Benton. At an early age he entered the employ of the old Boston, Concord & Montreal R.

R., and was promoted through several stages until he reached the position occupied by him at the time of his death.

Mr. A. C. Walbridge died at Oyster Bay, N. Y., Aug. 22. He graduated from the School of Mines of Columbia College in 1876. For a time he was engaged in railway engineering, and helped to build the Third Ave. elevated railway and the Coney Island & Brooklyn R. R. For 15 years he had been a builder and erected many large structures in New York and Brooklyn. His last work was the new "Eagle" building in Brooklyn.

Col. Henry Clay Nutt, formerly President of the Atlantic & Pacific R. R. Co., died Aug. 15 at Boston, Mass., aged 59 years. Col. Nutt was born in Montpelier, Vt., and began life as a train newsboy. He worked into the railway servic, and in 1851 became Chief Engineer of Construction of the Peoria & Oquawkaw R. R., now part of the Chicago, Burlington & Quincy R. R. From 1857 to 1876 he was Chief Engineer of the Council Bluffs & St. Joseph Ry., and until the completion of the Union Pacific Ry. bridge, over the Missouri, he was a contractor for the transfer of freight over the river. He then engoged in the elevator business in Chicago until 1881, when he went to Boston to accept the Presidency of the Atlantic & Pacific R. R. Co. He resigned in 1889 because of ill health.

Prof. Wm. H. Burr has been appointed to take charge of the department of Engineering in the Lawrence Scientific School of Harvard. Prof. Burr graduated from the Rensselaer Polytechnic Institute in 1872, and was then for three years engaged with a bridge company in New York, and on the water supply and sewerage system of Newark, N. J. He then became a member of the faculty of the Rensselaer Polytechnic Institute as Assistant Professor and Professor of Rational and Technical Mechanics for nine years, and during that period published his well known books on "The Stresses in Bridge and Roof Trusses, Arch Ribs, and Suspension Bridges," and "The Elasticity and Resistance of the Materials of Engineering." He also acted during this period as Consulting Engineer to the Delaware & Hudson Canal Co., the water-works and sewerage system of Lansingburg, N. Y., etc. In 1884, when the formation of the Union Bridge Co. caused the organization of the Phoenix Bridge Co. he accepted the position of Engineer of Construction of the latter, and subsequently became General Manager. It was under his supervision that the large bridge structures of that company (among them the Chesapeake & Ohio bridge at Cincinnati, the Red Rock cantilever, the Pecos viaduct, etc.) were designed and executed. In April, 1891, he became Vice-President of Sooysmith & Co., consulting and contracting engineers for bridges, bridge foundations, and pneumatic subaqueous work, tunnels, etc. He has also been associated with Mr. Alfred P. Boller, Consulting Engineer, of New York city, on the large bridge now being built by that city across the Harlem River.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF JULY, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.) Average	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average	Max.	Direction at time of max. velocity.	Precipitation—(Rain and melted snow)—inches. Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	66.0	90	38	52	7.4	45	W	2.88	1.07	12
	Portland, Me.	68.8	90	49	41	7.6	30	NW	2.68	1.30	9
	New York City	74.8	96	56	40	7.3	40	SW	2.45	1.02	9
	Pittsburg, Pa.	73.4	96	53	43	4.6	38	W	5.88	2.16	14
	Chicago, Ill.	71.6	94	53	41	13.6	45	SW	2.23	1.41	9
	Omaha, Neb	76.9	100	54	46	6.6	42	NW	3.64	1.26	10
	St. Paul, Minn.	71.3	90	51	39	5.9	25	SE	9.04	5.67	11
	Duluth, Minn.	69.6	93	50	43	5.0	24	SE	2.18	1.08	6
	Bismarck, N. Dak.	68.6	90	44	46	9.8	46	N	3.13	1.72	8
	Average	71.1	93.2	49.8	43.4	7.5	37.2		3.79	1.85	10
Southern Cities.	Washington City	75.8	99	54	45	4.7	36	NW	5.04	1.46	11
	Louisville, Ky.	76.7	98	58	40	6.1	44	NW	3.93	2.41	11
	St. Louis, Mo.	77.1	96	58	38	9.7	48	NW	4.64	1.45	13
	Savannah, Ga.	80.3	97	65	32	6.9	24	W	6.37	2.08	17
	Leavenworth, Kan.	76.2	98	54	44	7.3	32	SW	3.42	1.10	10
	Jacksonville, Fla.	81.7	95	66	29	6.8	31	SW	3.16	0.96	15
	Chattanooga, Tenn.	77.9	94	62	32	4.0	26	N	6.40	1.10	17
	New Orleans, La.	80.1	93	67	26	6.4	24	NW	7.46	1.91	18
	Memphis, Tenn.	78.6	96	63	33	5.5	29	NW	7.55	3.74	11
	Palestine, Tex.	82.2	97	67	30	5.3	18	S	1.60	1.26	5
	Average	78.7	96.3	61.4	34.9	6.3	31.2		4.96	1.78	13
Western Cities.	Helena, Mont.	65.0	91	45	46	7.7	54	SW	2.27	0.74	13
	Port Angeles, Wash.	54.8	76	43	33	6.7	29	W	0.33	0.12	8
	San Francisco, Cal.	58.1	90	50	40	12.0	36	W	0.00	0.00	0
	Salt Lake City, Utah	76.0	96	55	41	6.8	34	S	Trace	Trace	0
	Denver, Colo.	71.9	97	49	48	7.3	40	NE	1.19	0.32	14
	Yuma, Ariz.	90.4	112	66	46	6.3	30	SW	0.00	0.00	0
	Santa Fé, N. Mex.	69.8	86	53	33	7.4	37	SE	2.12	0.77	16
	Average	69.4	92.6	51.6	41.0	7.7	37.1		0.84	0.28	7

NEW PUBLICATIONS.

PASADENA & MOUNT WILSON RAILWAY.—Mountain Railway in Europe and America. Considered as an Investment in Connection with the Pasadena & Mount Wilson Ry. 8vo., pp. 291; illustrated.

This is a reprint of articles from the "Californian Illustrated Magazine" and other papers, containing several fine views of the scenery along the route. The railway was projected by Prof. T. S. C. Lowe, and was described in our issue of July 14. It is one of remarkable attractions, though of no special novelty from an engineering point of view.

FINAL REPORTS OF THE IRRIGATION INQUIRY. Part I. A Report on Irrigation and the Cultivation of the Soil Thereby, with Physical Data, Conditions, and Progress Within the United States for 1891. Accompanied by Maps, Illustrations and Papers.—By R. J. Hinton, Special Agent in Charge of Irrigation Inquiry, U. S. Department of Agriculture. Pamph., 8 vo., pp. 450; 56 plates of maps, diagrams and reproductions of photographs. Part II. Report of the Chief Engineer, Edwin S. Nettleton, C. E., with Accompanying Maps, Profiles, Diagrams and Additional Papers. Pamph., 8vo., pp. 116, and 29 folding sheets of profiles, diagrams, maps and tables. Part III. Geological Reports of the Artesian and Underflow Investigation Between the 97th Meridian of Longitude and the Foothills of the Rocky Mountains.—By Prof. Robert Hay, F. G. S. A., Chief Geologist. Pamph., 8 vo., pp. 209, and 19 maps, profiles and reproductions of photographs. Part IV. Report on the Mid-Plains Division of the Artesian and Underflow Investigation, etc., by Special Agent J. W. Gregory, and a Special Report on Certain Artesian Conditions in the State of South Dakota, by Fred. F. B. Coffin, Engineer for South Dakota. Pamph., 8vo., pp. 61, and 20 illustrations.

The previous reports on the irrigation inquiry and artesian well investigations have been fully noticed in these columns. The final reports contain much valuable information regarding the conditions and progress of irrigation in the United States, together with what has been accomplished and may be expected from attempts to develop water from artesian wells and from other subterranean sources.

The first report on artesian wells was very fully reviewed in Engineering News for Feb. 14, March 14 and 28, April 4 and May 16, 1891. The principal facts in the final report regarding irrigation in the several states and territories, more especially its status in 1891, were presented in Engineering News of March 5, 1892.

These final reports contain much matter not to be found in the preliminary and progress reports, and which can only be mentioned briefly at this time.

In Part I. Mr. Hinton gives an interesting general review of irrigation in the United States. This is followed by more detailed information regarding each irrigated state and territory. Mr. C. E. Grunsky, C. E., contributes a valuable paper with many illustrations describing different methods of applying water to land in Southern California. About 20 pages are devoted to a translation of parts of the work of M. J. Charpentier Cossigny on Agricultural Hydraulics. Appended to Part I is an abstract from the Manual of American Water-Works for 1889-90 giving information regarding the water-works east of the "arid region" which have their supply from artesian and underflow sources.

Part II. contains some detailed descriptions, plats and profiles of level lines run in connection with a study of the underflow in the valleys of the Platte and Arkansas rivers and many facts and figures regarding artesian wells not previously published.

Part III. deals with the geology, topography and water supply of the plains. The artesian wells of North Dakota are discussed as are the general conditions of artesian flow, and facts regarding the underflow.

Part IV. discusses still further the general character of the underflow, the means to be employed in making it available and the artesian basin of the Dakotas.

SOCIETY PROCEEDINGS.

NEW ENGLAND ROADMASTERS' ASSOCIATION.—The tenth annual convention was opened at Cooley's Hotel, Springfield, Mass., Wednesday, Aug. 24. After the regular routine business of the association, the election of new members, reading of communications, election of officers and miscellaneous business, the committees' reports upon the following questions were taken up for discussion: (1) Comparison of the Heavy Rail Sections Now Advocated for Use, with Light Rail Sections; Should there be an Increase of Labor to Roadbed to Get Full Life and Value from Use of the Heavier Rail. (2) Fire Damage; How to Lessen the Number of Fires and the Best Method of Adjusting Claims. (3) Is Not the Use of Cheap and Therefore Inferior Material and Tools Detrimental to the General Economy of a Road? (4) Review of Previous Year's Questions. In place of the customary excursion the association entertained its friends at a banquet on Wednesday evening. The proceedings of the convention will be given at length in our next issue.

ENGINEERS' CLUB OF CINCINNATI.—At the June meeting the subject "What to Do With Mill Creek and Its Valleys" was taken up and discussed by Col. W. L. Robinson in a short paper advocating the filling of the valley for a certain distance and appropriating the same for railway yards and terminals, reserving space for the passage of the creek. Its use for a harbor of refuge for steamboats and as a terminal for a ship canal, to be made by enlarging the Miami Canal, was also advocated by some. The valley is being slowly filled as new streets are made and improvements established within its limits, but no definite action looking to its ultimate availability has ever been taken.

The valley within the city limits proper is a mile or more in length and a half mile or more in width and from 20 to 40 ft. below the established grade of the streets in that vicinity, and the question as to the ultimate use to which it would be put has been and is a problem requiring, for any purpose, the expenditure of millions of dollars and years of time.

J. F. Wilson, Secy.

Aug. 18, 1892.

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Sept. 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 2. Secy., O. von Geldern, 819 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Sept. 3. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Sept. 3. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 3, 1122 Girard St. Secy., L. F. Rondinella.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 7. Secy., F. Collingwood, 127 East 23d St., New York
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 8. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Sept. 8. Secy., O. H. Landreth, Nashville, Tenn.
WISCONSIN POLYTECHNIC SOCIETY.
Sept. 12. Loan & Trust Bldg., Milwaukee. Secy., M. G. Shinke.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Sept. 12. Secy., C. L. Annan.
NEW ENGLAND RAILROAD CLUB.
Sept. 12. Secy., F. Curtis, B. & A. R. R., Boston.
DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 13. Secy., Geo. H. Angell.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept. 13. Seattle, Wash. Secy., E. H. Warner.
MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOC.
Sept. 14. At Detroit, Mich. Secy., Robt. McKeon, Kent, O.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Sept. 15. Secy., C. F. Franson, 113 Adams St.
ENGINEERS' CLUB OF CINCINNATI.
Sept. 15. Secy., J. F. Wilson.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Sept. 17. Secy., F. D. Jones, Helena.
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., E. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richards, Brooklyn, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22. Roanoke, Va. Secy., J. K. Schick, Roanoke.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

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AND

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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It was a notable and amusing fact at the last M. C. B. convention that the "Committee on Heating and Ventilation of Passenger Cars" said not one word about ventilation, though that is well known to be in a very much more backward and defective state than the heating arrangements. It was symbolical of the scant attention given to ventilation by rolling stock officials, with the result that the ventilation of cars, especially sleeping cars, in which the need of good ventilation is greatest, is almost universally defective. The solution of the problem of proper ventilation is complicated by the heavy hangings and the necessity, in most cases, of providing for the exclusion of the showers of cinders which rain down on the roofs and sides of the cars. The more general introduction of compound locomotives may incidentally tend to simplify this part of the problem, which is in large degree peculiar to this country. On some of the English railway cars, small exhaust fan ventilators are fitted in the upper part of the sides or in the roof, the draft being regulated by the passengers, and with the free access of air at the loosely fitting sliding windows, and at the bottom and sides of the numerous side doors, the ventilation is fairly efficient, with rather too great a tendency to drafts and an excess of cold air. On a parlor or sleeping car with all the double windows closed, as is usually the case, there is too little provision for the entrance of fresh air. We are disposed to think that one reason why so little progress is made, is that ventilation is sought chiefly by roof openings. It would seem as though efficient ventilation, without draft, might be obtained by means of protected openings at the floor level, with or without external hoods, and exhaust ventilators in the sides of the roof, leaving the side openings of the clearstory and the smoke jacks of the lamps to provide for the removal of the hot air in the clearstory. Experiments have been tried in this direction, as in others, but no experiments at all seem to have been made with much earnestness. At the first difficulty they have been discontinued. In the ordinary day, parlor and sleeping cars, the side windows of the clearstory are still mainly relied on for ventilation, which it was long since clear that they cannot adequately provide for. As yet the problem of ventilation has not been taken up seriously by any company, being considered, apparently, as a secondary matter.

The aeration of water supplies is a subject of great practical interest and importance. It appears, however, from a paper by Prof. T. M. Drown, printed elsewhere in this issue, that both the popular and scientific conceptions of what can be accomplished by aeration are at fault in so far as it is thought that the purification of water from organic pollution is possible by hastening oxidation through the introduction of more air into the water. To determine just what aeration will do for water Prof. Drown experimented for two years. The results of his experiments are very interesting. His conclusions are as follows:

(1). The oxidation of organic matter in water is not hastened by vigorous agitation with air or by air under pressure.

(2). The aeration of water may serve a useful purpose by preventing stagnation, by preventing the excessive growth of algae, by removing from water disagreeable gases and by oxidation of iron in solution.

The first of these concise statements will doubtless cause much surprise, for, as Prof. Drown says at the beginning of his article, it is very common to connect mountain streams breaking over stones and waterfalls with a natural process of purification. While aeration has actually been employed in this country mostly to prevent stagnation, the growth of algae or to remove unpleasant odors from water, all of which Prof. Drown says it will do, no small amount of faith has been placed in it as a means of removing gross organic impurities from water, while it has even been claimed that aeration would kill bacteria. But bacteria, we are just beginning to recognize, are absolutely essential to nature's processes of purifying water contaminated by inert organic matter, being no less necessary than oxygen. Prof. Drown's experiments reveal more fully than heretofore the important functions of bacteria, and are a notable addition to the knowledge of water supplies and their purification.

An option to buy the works of a water company at an appraised valuation is one of the most valuable rights a growing city supplied by private waterworks can possess, and one which it should surrender under no conditions. This is true because: (1) Every growing city will sooner or later desire to own its works, and (2), a purchase option insures a city a possible good water service, either by quickening a company's desire to give such service or by permitting a city to buy and operate the works itself. The city of Dubuque, Ia., has been supplied by a water company since 1871, under a franchise which provides that the city may buy the works at any time at an appraised valuation. An outside company now wishes to buy the works and has requested the city to waive the right to purchase the property; but, according to the Dubuque "Telegram," offers nothing in return, unless it be much-needed improvements, which should be made in any case, both because they would be for the company's interest and are in line with its plain duty as a public servant. It seems that the city's option to buy the works has not helped it to secure good service from the old company, for the reason that the city is near the legal limit of its indebtedness and thus cannot buy the works. But the company's franchise or charter has 28 years longer to run, long before the end of which the present financial condition of the city should be so improved that the purchase of the works will be possible. If it were absolutely certain that the city would not be able to buy the works during the period named the company would not care to have the option waived. The option is valuable, and it would be a very false idea both of municipal economy and of the duty of such public servants as water companies for the city to surrender this valuable right in consideration merely of an agreement to improve and extend the works, which it has a right to expect in any case. The population of Dubuque in 1890 was 30,311. There were in 1890 just 100 cities in the United States larger than Dubuque, of which 71, according to the "Manual of American Water-Works for 1890-'91," had water-works under municipal control. Of these 71 cities 20 or more were originally supplied wholly by private companies, but have since established their own works, by purchase or construction. A few of the 71 cities have a limited territory still supplied by private companies. These figures show, as has previously been shown in these columns, that our large cities prefer to own and regulate their water supplies and emphasize the value of the option held by Dubuque to buy its works at an appraised value.

The apparent inability of English engineers to grasp the economic and commercial as well as the constructive principles involved in engineering and construction works, as exhibited in their expensive railway work in India and the colonies, was considered in our issue of Aug. 4. A similar inability seems to have characterized two great works in their own country. In our issue of Aug. 18 we referred to the fact that the new Vyrnwy water supply for Liverpool included much work of an absurd and unnecessarily expensive character. A similar practice seems to have been followed on the Manchester Ship Canal, as will be seen by a note in our news columns. With an original estimate of $45,000,000 the work has already cost about $65,000,000, and is expected to cost $85,000,000 before it is completed. The directors who represent the city of Manchester on the board of the company complain that much work has been done which cannot possibly be required or earn anything for a considerable time, and which will therefore be a dead weight on the earning portion. The city has already invested $15,000,000 (Eng. News, April 4, 1891), and is likely to have to put in $7,500,000 more to prevent the collapse of the enterprise. Of the ability of English engineers to successfully carry out large and difficult works there can be no question, but they certainly seem to consider economy, or any question of expense, as a matter rather beneath their notice, and require an unlimited supply of money, which is not always forthcoming in these commercial days. The first end and aim of an American engineer constructing a canal or railway is to get it in operation as quickly and cheaply as possible without doing work that will be thrown away, so as to secure immediate returns, and then gradually to extend and improve the work to the desired standard and capacity.

Among all the hundreds of new devices and designs which are described in these columns in a year there are surprisingly few which are radical departures in type, and yet not such radical departures mechanically as to forbid one to look upon them as anything more than hopeful but dubious experiments. One such, however, is described in this issue, the Reno "continuous elevator," which is quite new in type, and yet so simple mechanically as to leave small ground for anxiety in that direction. We are frank to say that it seems to us to promise to fill well a void which has not yet been filled, that, namely, between a common stairway and the now familiar vertical elevator. It is simple, being nothing more than a gently inclined traveling platform, with a traveling handrail alongside of it, on which one steps at any instant and is gently moved forward and upward for a lift of 10 to 15 ft., at the rate of about a foot per second or a little less. So far as we could see there was not the remotest chance of the youngest or weakest person being injured or even alarmed in stepping on it for the first time, while the ascent of one story is made in less than half the time which the fastest vertical elevator would consume, if we include also the average time lost in waiting.

For lifting a large crowd up one or two stories, therefore, such an "always ready" lift as this should prove highly advantageous as well as economical. The vertical lift is rather clumsy for that purpose, as any one can see by entering one of our large dry goods stores. On the other hand, for either large or small lifts with a small traffic, a continually moving platform of this nature, which requires no attendant for its use (the principal cost of elevator service), should have a considerable field of application which the vertical type cannot and does not fill. At the coming Columbian Exposition there should be many places where such a continuous elevator should be of use, and thus serve as an exhibit and a convenience at the same time.

SEWAGE PURIFICATION AND STORM AND GROUND WATER.

A new impetus seems likely to be given to the separate system of sewers by the present movement for the purification of sewage, which renders necessary or desirable the exclusion of ground and storm water from sewerage systems. The necessity for such exclusion is brought out in the series of articles which we are now publishing, "Sewage Purification in America."

At Marlborough, Mass., as shown elsewhere in this issue, the daily flow of sewage equaled the total

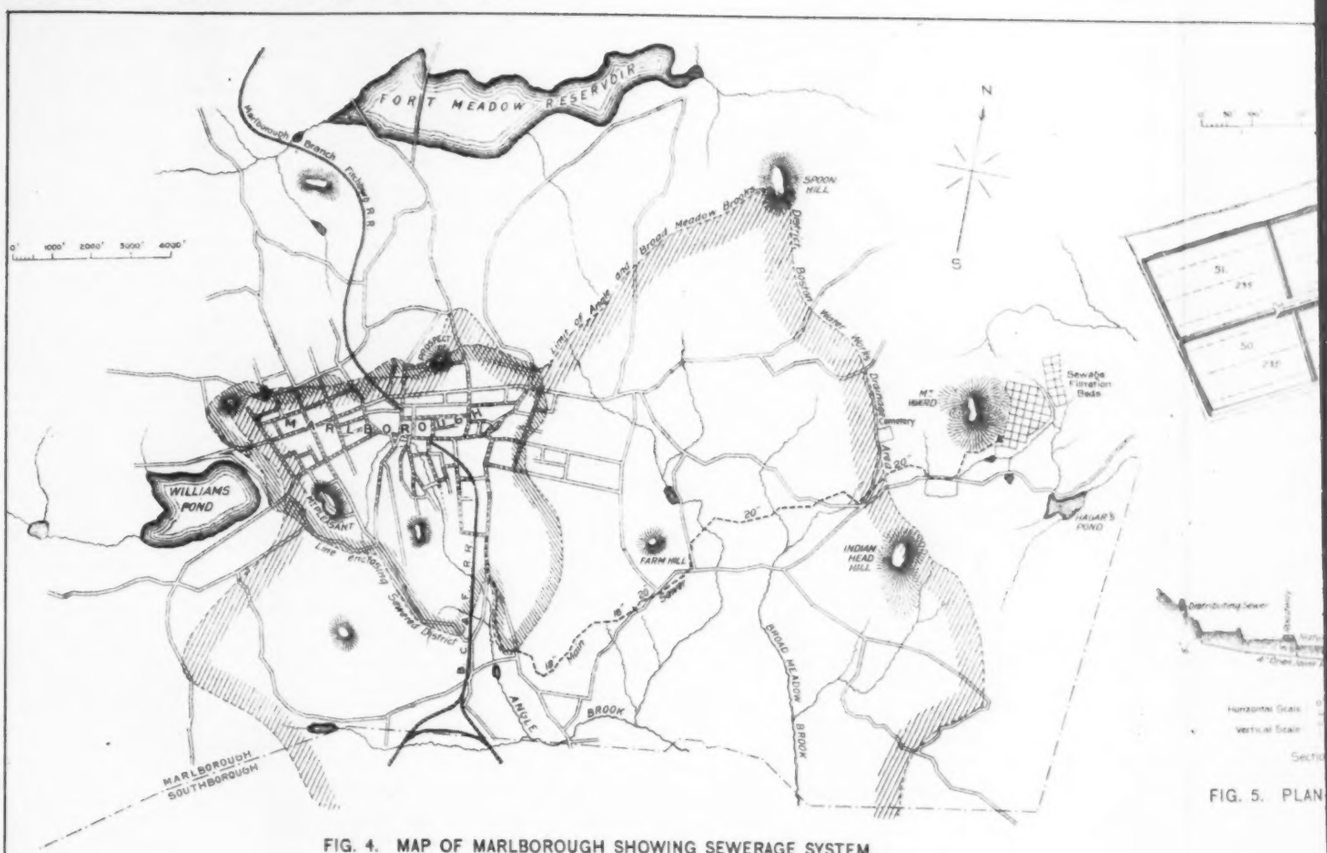


FIG. 4. MAP OF MARLBOROUGH SHOWING SEWERAGE SYSTEM.

FIG. 5. PLAN

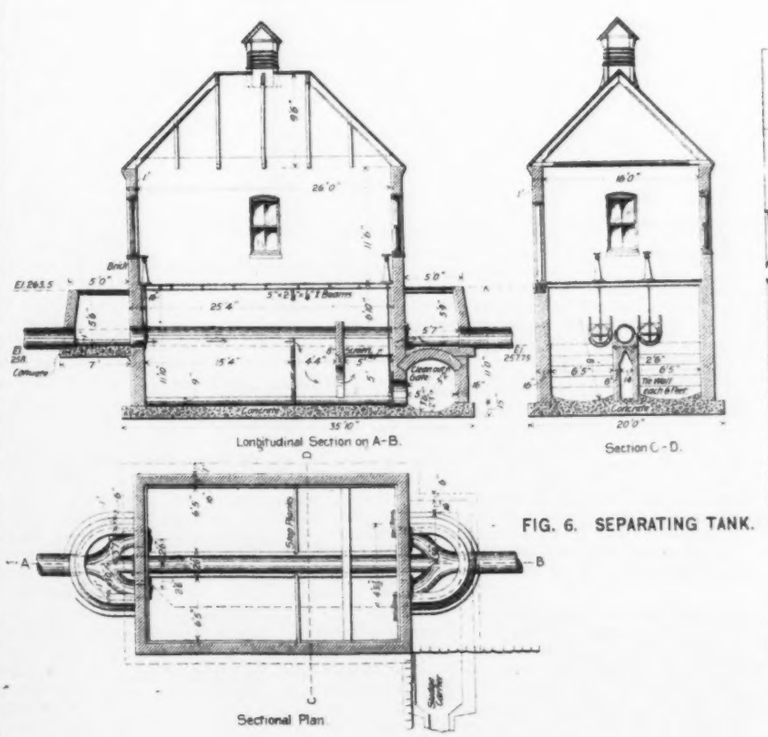


FIG. 6. SEPARATING TANK.

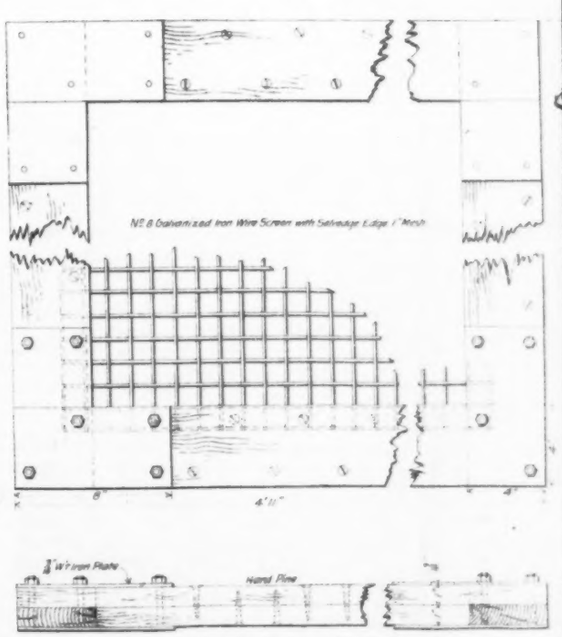


FIG. 9. SCREENS IN SEPARATING TANK.

SEWAGE PURIFICATION PLANT AT MARLBOROUGH, MASS.

Mr. M. M. Tidd, M. Am. Soc. C. E., Boston, Engineer.

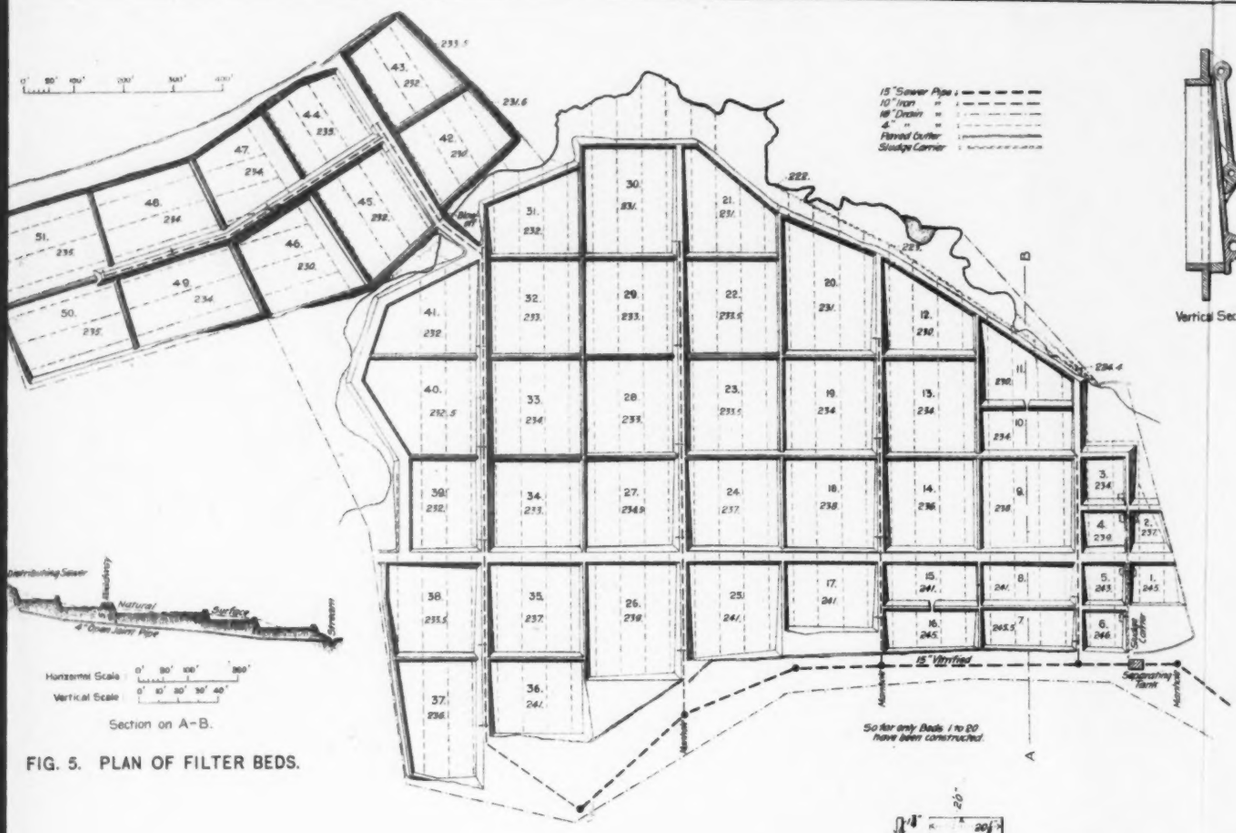


FIG. 5. PLAN OF FILTER BEDS.

FIG.

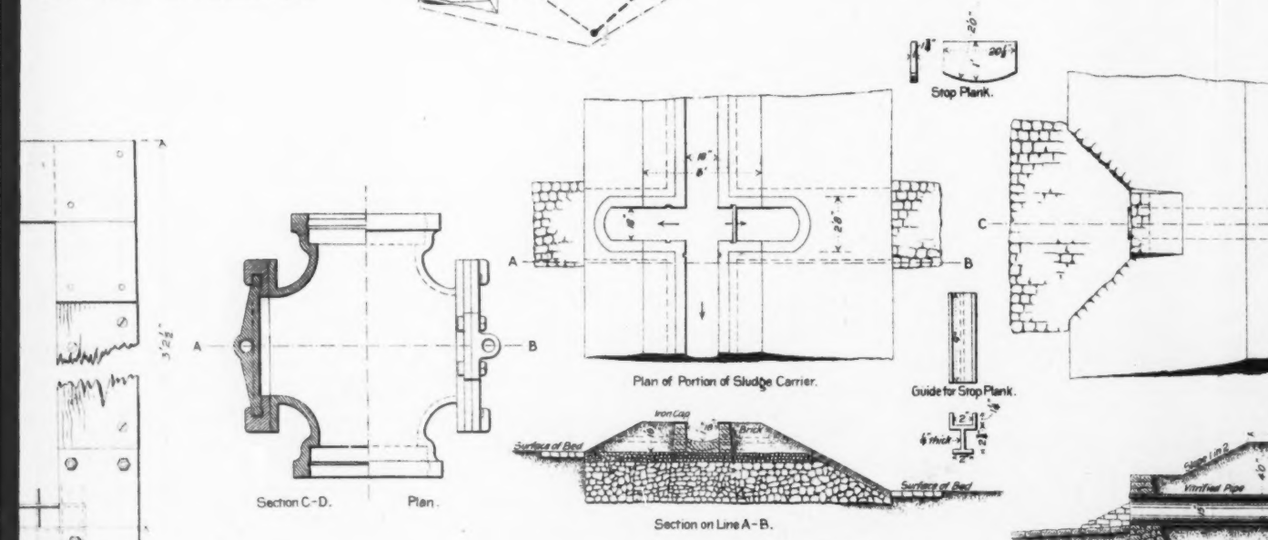


FIG. 12. SLUDGE CARRIER.

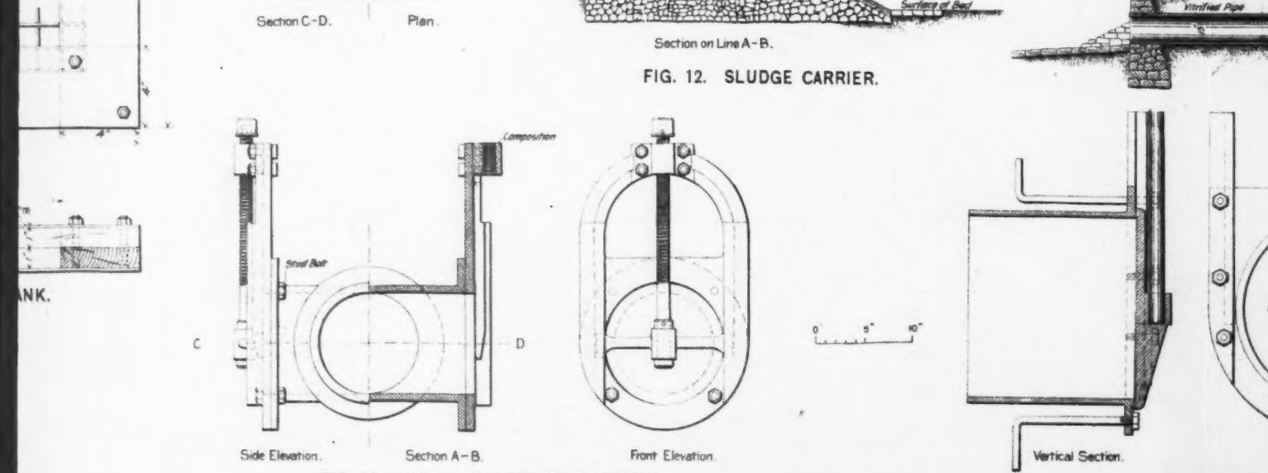
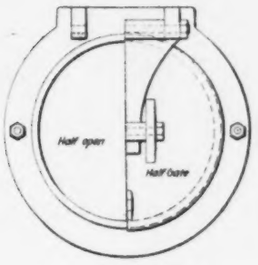


FIG. 11. 10-IN. GATE TO FILTER BEDS.

FIG. 7. 18-IN. INFLUENT GATE.



Front Elevation.

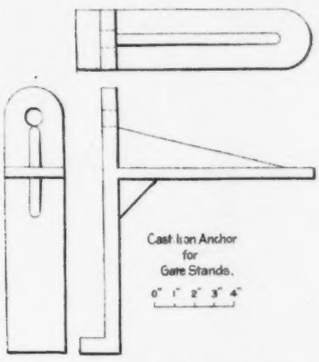
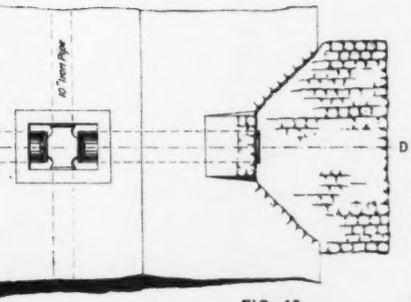
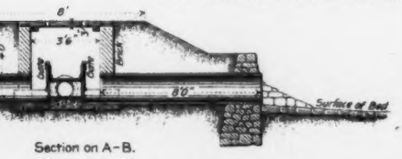


FIG. 8. 18-IN. SWINGING GATE.

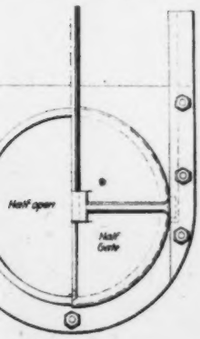


Plan.

FIG. 10.
OUTLETS AND FILTER BEDS.



Section on A-B.



Front Elevation.

NT GATE.

CHAS. HART & SONS, LITH, 98 VESEY ST., N. Y.

daily consumption of water at a time when the number of sewer connections was less than one-fifth the number of water connections, or taps. This was in dry weather. After heavy rains the volume of sewage was about double the consumption of water. The admission of ground water to the sewers is the only explanation of these facts.

The ground water at Marlborough has not given trouble as yet, and need not in the future, provided available land is brought into use for the intermittent downward filtration there practiced. The danger, at Marlborough and elsewhere, is that no allowance having been made for ground water at the start its admission to the sewers will overtax the capacity of the disposal plant provided. Thus the sewage will not be thoroughly purified. Where filtration or broad irrigation is used for purification an excess of sewage may keep the ground so constantly water-soaked that its efficiency will be entirely destroyed, the land never having a chance to rest or, literally, to breathe. It is evident that if the interstices of the filtering material are constantly filled with water the air must to a large extent be excluded. This retards or stops the process of nitrification by which the harmful organic matters in the sewage are changed to harmless inorganic substances.

Chemical precipitation plants may be overtaxed by the admission of ground water to the sewerage system, as is the case at East Orange, N. J. There somewhat elaborate machinery and subsequent filtration are employed, so that an increase in the volume of sewage to be treated is not merely a matter of adding more chemicals, but requires a more capacious plant.

At Worcester, Mass., as shown in our issue for July 28, the volume of sewage is far in excess of the original capacity of the purification plant, (chemical precipitation), which is now being enlarged. This excessive amount of sewage is doubtless caused by both storm and ground water, although it is attributed to storm water alone. The eventual outcome of the difficulty at Worcester will doubtless be the separation of the storm water and sewage. Quite a step in this direction can be made by dividing the present outfall sewer into two channels, as is proposed. This outfall was originally a brook of some size, and still receives all the natural drainage to the brook. Sewage was turned into the brook before sewage purification was proposed, and separation can be effected only at a considerable expense. The brook has been turned into a closed channel through a part of its length.

When sewage purification is adopted in cities like Worcester, where the combined system is in use, as is the case in nearly all cities and towns of size, the problem of excluding storm and ground water is a serious one. Where sewers are being introduced separate systems can be used, and efforts can be made to exclude ground water.

Underdrainage may sometimes be effectively employed to overcome the difficulty, but the same cause which renders sewage purification necessary may make underdrainage inadmissible, as is well illustrated by the situation at Marlborough. At this place, as stated elsewhere, the city of Boston contributed to the expense of the sewage system in order to remove and exclude the sewage from its water-supply. On the ground that a sewer pipe which would admit ground water would also admit sewage, Boston refused to allow underdrains, the town proposing, it would seem, to discharge the underdrainage into the same stream as the sewage had been excluded from. If the underdrainage were to be conveyed to the disposal plant, then it might as well be carried in the sewers as in underdrains, unless it was desired to lower the level of the ground water beneath the sewer line.

At South Framingham, Mass., Boston refused to contribute toward the expense of the sewage purification plant, described in our issue of Aug. 11, because underdrains had been put in for a part of the sewers, although none were proposed in the plans approved by Boston.

In an old town where cesspools and privies have been used for many years it is evident that the underdrainage, after the introduction of sewers, would be somewhat polluted, until the ground had become purified through the operation of nature. Therefore it might be desirable to exclude the ground water, when collected in quantity by underdrains, from any stream used for drinking purposes. In such cases it might require purification, and from this point of view its admission to the sewers would not be objectionable. But as has been said, sewers that will admit groundwater will emit sewage, which is highly undesirable, and for this reason sewer joints which will not leak are needed.

Thus far only the inefficiency of purification plants, as caused by storm or ground water, has been mentioned. Inefficiency can be avoided by constructing sufficiently large plants, but only at an increased expense for construction and operation.

Sewage pumping plants and long lines of outfall sewers, it may be added, are also rendered more costly by the admission of either storm or groundwater.

From what has preceded it is evident: (1.) That all storm water should be excluded from sewerage systems where purification is used. (2.) Ground water should also be excluded, provided it does not itself need purification. (3) All possible care should be taken in the laying of any sewer pipe and especially that in connection with sewage disposal plants to provide against leaky joints or cracks in the pipe through settlement or other causes. If there are any defects in the pipe itself attempts should be made to remedy them. (4) It may well be added that more data is needed to enable engineers to study the ground water problem with the care which it deserves.

POLITICIANS AND ENGINEERS.

A valued correspondent in Chicago sends us the following letter. We infer that it was not intended for publication, but merely to give information; but we take the liberty of publishing it, after eliminating one or two expressions of a too personal nature, as saying in itself about all that we wish to say:

Sir: Mr. Bernhard Feind, M. Am. Soc. C. E., etc., has been connected with the City Engineering Department of Chicago since 1885, until one month ago. He had by hard work and on his merits, worked himself up from a $100 per month to a $3,000 per year man, and was First Assistant City Engineer. He has had charge of all the large work in hydraulic engineering for several years, and from a personal knowledge of the situation I do not hesitate to pronounce him the most capable engineer of the department, not even excepting the City Engineer himself. But although he has thus worked himself up, on his merits as an engineer, as a politician he was not successful; rather, he refused to resort to political methods to hold his place. A plot was formed to get him out, because he would not give his time to politics instead of to engineering, and it was decided by the Mayor and others that he would have to go. As soon as Mr. Feind heard of this he resigned and has since started an office as a consulting engineer. It seems as if Engineering News should have something to say about occurrences of this kind, thereby raising the standard of engineering and protecting engineers in a measure from such assaults by politicians. The engineers of the country feel that they have a right to expect this of you. This dismissal of Mr. Feind is a clear and a bad case of politics; of throwing out a competent engineer for political reasons only. Moreover, this is not the only case in this city. I know it to be a fact that many, if not all, of the assistants in the City Engineer's Department have been obliged to get the indorsement of the ward club in the ward they live in in order to keep their position, and a number of them, moreover, have been notified that they must "get out and do political work" in their ward to keep their positions. As one particular instance: I am told on most excellent authority that one D. N. Jamieson has been given power to make all appointments and engineer all discharges in the entire engineer's department, i. e., without consulting the City Engineer, the Commissioner of Public Works or any other party except the Mayor. Such things ought to stir up righteous indignation of every engineer and every engineering journal.

Hardly had this letter been received when we chanced to notice confirmatory evidence of one of its charges in the following extract from the Chicago "Mail" of Aug. 3, 1892. The extract relates only to the discharge of a private secretary of the Chief of Police, but it concerns the same Jamieson who is mentioned in the above letter, and is otherwise so characteristic of the ways that are dark and tricks that are not vain of city politicians, and hence so pertinent, that we give it nearly in full. It throws a strong side light on the ways of city politicians. It is pertinent, that we give it nearly in full. It is headed: "Perkins Loses his Job:"

Quite a flutter was caused in the police department and City Hall circles by the removal of Chief of Police McClaughry's private secretary, T. L. Perkins, upon request of the Mayor.

Mr. Perkins says that he had no trouble with the Mayor direct, but had a clash with Dr. Jamieson, and was rather independent toward heelers who claimed to have a "pull" with the Mayor when they would call and insist upon seeing the chief instanter. He claims that his appointment was not political in any sense, but a personal one on the part of Chief McClaughry, whom he had served before. He attributes his removal entirely to Dr. Jamieson. Mr. Perkins' statement is as follows:

"One day Jamieson said to me: 'I want you to understand that when I send an order into the chief's office I want it obeyed.'

"I told him he had no right to talk so to me; that if he wanted to communicate with the police department he should speak to the chief and not to me.

"A few days after I received a letter from the Mayor saying that I must obey Jamieson's requests and give him the same attention as if the requests were signed by the Mayor. I turned that letter over to the Chief of Police, and as a result I have been asked for my resignation by the Mayor."

Chief McClaughry states that there are no charges against Secretary Perkins.

What can be done to remedy such evils as this? We know of nothing which engineers can do except to make the facts connected with every such instance as public as possible, and that can be at best but partially effective, for the simple reason that it is impossible for the sufferer himself to expose effectively the nature of the act. The mere fact of his discharge places him under a certain stigma. He is always open to the accusation of being a "sorehead," and of speaking from interested motives to explain away a removal for cause. If some friend takes up the cudgels in his behalf his information comes at second or third hand, and for that reason loses much weight. As for other men in office, they cannot speak without endangering their own heads, and they are therefore rarely willing to speak.

Hence both the sufferer and his friends choose, as a rule, to make the best of a bad matter by saying nothing about it, and either going to work to oust some one else in their turn, or giving up political engineering in disgust and seeking for some other and non-political engagement.

For like reasons it is impossible for a journal like this to do much to stop such procedures; and not wishing to beat the air without effect we rarely say anything about them. The great obstacle to a more positive course is a lack of intimate knowledge of all the facts. Discharges and appointments for political or personal motives only are continually going on, we have every reason to believe. If it were possible to record every such incident exactly as it occurred, and have all the facts believed, we have no doubt that the indignation and disgust of the public would be so stirred as soon to put a stop to them, at least in professional appointments like those on the engineering staff. But it would not be possible to do this with any amount of trouble, and it would take an immense amount of trouble to even approximate to it. Therefore we can neither do much or say much about these frequent cases of political removals, iniquitous as we know most of them to be.

For example, we fully believe that our correspondent's statements of the main facts in the above case are entirely reliable, but to make sure of it we should have to enter into an extensive investigation of the past and present of every man concerned, and to make other people equally sure of it we should have to spread all these facts with equal detail upon our pages, with the certainty of occupying a great deal of space; with the possibility of falling into some serious error, and with a strong probability that some unimportant alleged error might be made a handle of to obscure the main issue. We have been frequently asked to investigate and expose wrongs of this nature, but have uniformly declined, for this reason alone. The sufferers themselves have like reasons for keeping quiet, and generally do so. The wrong is one without a remedy, which makes it all the meaner when done without cause. In time we may become so civilized that political motive will not control professional appointments at least. We are making some progress in that direction, but we are a long way off from it yet.

Until that happy day arrives our strong advice to every young engineer is to avoid working for cities if he can, as the meanest and most uncertain kind of professional employment, with some honorable exceptions. After that avoid working for states, and after that working for the general government. It is better as a rule to accept a considerably lower salary from a respectable corporation than to work for either of these three. But in comparison with employment under a private individual or firm or a

(comparatively) small business corporation, working for any large corporation is itself highly undesirable, if conditions are otherwise equal. And finally, if the engineer has the "stuff" in him to succeed without calling any man master (which is much easier now than ten years ago, and will be easier ten years hence than now) he will be wise to do it even at some considerable pecuniary sacrifice if he does not also sacrifice quality of experience.

LETTERS TO THE EDITOR.

A WHITE FLORIDA CEMENT.

Sir: I have been informed that there is a white cement made in Florida that is very hard and sets quickly. If you know of any such cement and where it is manufactured, will you please give me the address of the parties. I will be obliged for any information you can give me on the subject. Respectfully yours,

J. C. B.

Louisville, Ky., Aug. 15, 1892.

(We do not recall having heard of any such cement.—Ed.)

RATES OF MAXIMUM RAINFALL: CORRECTION.

Sir: My attention has been called to two typographical errors in the reprint of my article on "Rates of Maximum Rainfall," in Engineering News of July 21, page 67. The formula for storm water at the bottom of the third column should be

$$\int \frac{\times 6300}{\frac{1}{v} + b + 900}$$

The formula at the end of the article should read.

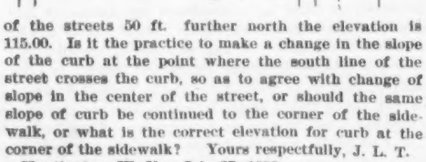
$$\frac{52.5}{\sqrt{A} + 20}$$

Yours truly, A. N. Talbot.

Champaign, Ill., Aug. 13, 1892.

FIXING STREET GRADES.

Sir: Here is a question as to street grades, which I trust you will give me an answer to: In the street here shown the elevation at the south end in the center of the street is 104.00, the east curb elevation opposite is 103.66. The elevation of the center of the street at the south line at the next cross street, 320 ft. north of the first point, is 114.34, and of the curb opposite 114.00, and at the intersection of the center lines



of the streets 50 ft. further north the elevation is 115.00. Is it the practice to make a change in the slope of the curb at the point where the south line of the street crosses the curb, so as to agree with change of slope in the center of the street, or should the same slope of curb be continued to the corner of the sidewalk, or what is the correct elevation for curb at the corner of the sidewalk? Yours respectfully, J. L. T.

Huntington, W. Va., July 27, 1892.

(Practice as to this point varies in different cities. The usual rule, we believe, is to make both streets level from the building line, and to break the grade of the street running up and down hill at the building line of each cross street to correspond. This always gives the cross street the appearance of pitching to ward the hill, however, and gives the street running up the hill a very ugly look. To avoid this the cross-section of the cross street is often given a decided slope down hill, but on the whole, we think both reason and preponderance of practice favor making it level transversely.—Ed.)

A QUESTION OF MONUMENTS.

Sir: If you will decide the following question for us or submit it to your readers we will be much obliged:

In running a random line from x to y (see accompanying sketch, which is not to scale), through the

center of a section we find stones set at f, d, and e, that have been there for more than 30 years. Since these stones were set, a surveyor runs the line fgh, which seems to have been run on a line from f to e.

Property owners living on tracts A and B had two old surveyors that have lived in that vicinity for many years to run the line. These surveyors agree that the line should run from f to d and the property owners have moved their fences to that line. This produces a jog of 17 ft. at d and the owner of tract C now wishes to move his fence to line dk, which if produced, would run to e. Property owner D refuses to have fence moved. What right has he to refuse?

All stones in case have been testified to as having been set by surveyors, between 30 and 40 years ago.

Yours truly, R. Z.

Joliet, Ill., Aug. 9, 1892.

(There may easily be modifying facts not stated in this letter which would control the decision; as, for instance, that the line f, g, h, e had been run on behalf of the tracts C, D, and had been mutually accepted through a long period of years; but if the stone monuments f, d and e were set by U. S surveyors, they will govern, we think, in spite of any subsequent and different lines, under the U. S. law, unless under some very peculiar and exceptional circumstances. The general principles governing the decision of this numerous class of disputes will be found on p. 229 et seq., of Johnson's "Surveying." —Ed.)

THE CHICAGO WATER SUPPLY.

Sir: Apropos of the discussion in regard to the pollution of the water supply of Chicago, would not a simple remedy be to construct a lock at the Lake Michigan end of the Chicago River, to be left open under ordinary circumstances, and only closed during times of freshet when the current carries sewage into the lake.

This, it seems to me, would be a cheaper way of obtaining a pure water supply at all times than extending the inlet pipes a sufficient distance away from the city to be at all times beyond the reach of the discharge of sewage. J.

New York, Aug. 15, 1892.

(It would hardly be practicable, as navigation must be kept open and the channel cannot be contracted, but even then it would only cure the evil from the Chicago River, not from the direct discharge of sewage into the lake. The simplest and the only perfect remedy, it seems to us, would be to run a pipe or masonry aqueduct from an intake 30 miles or more north of Chicago. The cost of this would not much exceed $250,000 per mile at a guess (54-in. steel pipe are now worth about $8 per ft. laid), and two 96-in. pipes, or a brick conduit of corresponding capacity, should carry Chicago's supply easily for a long time to come. With the new drainage works to create a southward current along the shore, all question of the purity of the water supply would then disappear forever. It would be worth its cost to Chicago for the moral effect alone.

WROUGHT IRON AND CEMENT WATER PIPES.

Sir: If I am not trespassing too much I would like to have you inform as to the strength, durability and general use of wrought iron and cement mains used in water-works, compared with similar cast iron mains. How long a time may wrought iron and cement mains reasonably be expected to endure?

Very truly, A. C. McLachlan.

Seneca Falls, N. Y., Aug. 9, 1892.

(So much depends on the quality of the cement used, the care with which it is made and laid, that it is impossible to lay down any general rule. Some wrought iron and cement pipe has given excellent service, but as a whole, the product has been found unreliable, and now has comparatively few friends. The following abstract from our report of the 1890 meeting of the New England Water-Works Association will show what they think of it down there, where it was once used quite extensively. —Ed.)

A paper by Mr. P. E. Crilly, Supt. of Water-Works, at Woburn, Mass., on "Why I Favor the Use of Cement Pipe," was read. After all that has been published in this journal and in numerous water-works reports on the eccentricities of cement pipe, it was with genuine curiosity and admiration that Mr. Crilly was looked at and listened to. At the conclusion of the paper a somewhat ominous quiet prevailed for a minute or two, when Mr. Walker, of Manchester, who it is understood, has had some experience with cement pipe, was called on to tell what he knew of the subject. Mr. Walker prefaced his remarks by saying that he had come from Manchester on purpose to hear this paper and look at the man who had courage to read it. Mr. Walker's remarks about cement pipe were forcible and direct, and he left no doubt in the minds of his hearers as to his opinion. He had tried cement pipe and he didn't want any more of it at any price. Other members told their experience, and there was not even one who encouraged Mr. Crilly in his peculiarity. Apparently he was so overpowered at the unanimity of condemnation of his favorite pipe that he concluded silence was wisdom, as he had no further argument to advance to sustain his position on the matter.

THE VESUVIUS CABLE RAILWAY.

Sir: I notice that in the last number of the News, in your description of "The Otis Elevating Cable Railway," it is stated that the funicular line up Mt. Vesuvius is operated in two divisions and that passengers have to change from one division to the other at the Atrio del Cavallo, where the power house is located. I cannot imagine where you have obtained this information, which is quite erroneous, unless the line has been entirely rebuilt since last March, when I ascended Vesuvius. This is unlikely, as there were no signs of any work on the mountain side for changing the line, and I should doubtless have heard of it if any change of this kind had been in contemplation.

As is well known the line belongs to a member of the firm of Thos. Cook & Son. Tourists are taken by this firm in carriages from Naples to the foot of the cone of the volcano, at a point a little beyond the observatory, from whence they ascend by the funicular, without change, to the summit. Neither the station nor the line is near the Atrio del Cavallo. The latter is a crescent shaped valley lying between Vesuvius proper and Mount Somma, which was the crest of the mountain before the present cone was formed in the great eruption of A. D. 79. The funicular railway ascends the opposite slope of Vesuvius, which faces the bay.

Wishing to visit the Atrio del Cavallo in order to see the fresh lava issuing from the ground, I took a guide at the summit and had to descend the cone on foot instead of by the railway, as otherwise the route would have been a circuitous one. Lava has been issuing at various points in this valley for a year or more, and it would therefore be a very undesirable place for locating a railway.

You are mistaken also in the length of the road, which is some 2,700 ft. only. About 12 minutes are occupied in the ascent. The road is of some interest from its being one of the few in which the track consists of a single rail. Yours truly,

J. F. Flagg.

Brooklyn, N. Y., Aug. 20, 1892.

(The figures used in the article referred to were taken from a recent edition of the "American Cyclopedia," which, in absence of contradictory data, we assumed to be correct.—Ed.)

PILE DRIVING FORMULAS.

Sir: I am anxious to have you take up and discuss the subject of "Pile Driving Formulas" as promised in your remarks on this question in the June 30 number of Engineering News. It is a subject I am very much interested in, as the firm I am connected with makes pile driving a specialty; and it is sometimes embarrassing to back up an asserted safe carrying capacity of a pile by some good published authority, and in turn be confronted by the formula of some other engineer of equally high standing, which proves, beyond the shadow of a doubt (in said engineer's mind), that this same pile will carry safely twice as much, or perhaps only one-half as much, as "you" asserted and attempted to prove by "your" engineer's formula.

To illustrate the great difference in results obtained by formulas of our most prominent authorities, a pile driven under certain conditions, viz., penetration under last blow, 6 ins., fall of hammer 20 ft., weight of hammer 3,500 lbs., we have the following safe loads to choose from, as calculated by five standard formulas, if my recollection of the Engineering News formula is correct.

I have no book giving the Wellington formula, but my recollection of it is as follows:

$$S = \frac{w\,h}{s+1}$$ (it should be $S = \frac{2\,w\,h}{s+1}$.—Ed.)

in which S=safe load in lbs.; w=weight of hammer in lbs.; h=fall of hammer in feet; s=penetration in inches at last blow.

Safe Loads.

Wellington's formula	10,000 lbs.
(Should be 20,000 as above. Ed.)	
Maj. Saunders' formula	17,500 lbs.
Engineering News' "	20,000 "
Trautwine's "	23,500 "
Haswell's "	32,500 "

The formulas of the first three authorities are calculated for a safe load, while those of Trautwine and Haswell are for the extreme load a pile will bear. In the figures shown above I have reduced their results from extreme to safe loads by using a factor of three, which I considered sufficient under most circumstances and more than sufficient for foundation piles.

I believe an average of these five results, or say 21,000 lbs. to be as nearly a correct safe load as can be calculated, which gives the Engineering News formula the medal for correctness, but the great variation in the results, as shown above, is calculated to shake a man's faith in the formulas of all authorities on the subject. Yours truly, J. N. Huston.

New Orleans, La., Aug. 3, 1892.

(The "great variation" which our correspondent finds is chiefly due to a fault of his own memory. There is no "Wellington formula," except the "Engineering News formula," which latter was first propounded, deduced and explained in our issue of Dec. 29, 1888, and has since met with much wider acceptance and use than was then expected. As was not then stated, however, this formula for safe load (claimed and believed to be absolutely safe for piles driven by blows under all conditions, if the set was uniform and fairly observed), was simply one-sixth of the ultimate bearing power, which was first deduced as follows:

$$\text{Ultimate load} = \frac{12\,wh}{S+1}$$

By this formula, compared with Trautwine's and Haswell's, the ultimate is as follows:

Engineering News formula	120,000	lbs.
Trautwine "	70,500	"
Haswell "	97,500	"

The Trautwine formula, however, using the cube root of the fall as one factor without the slightest warrant in theory, does not claim to be anything but purely empirical, and the accompanying remark, "For the safe load take from one-twelfth to one-half of this," might about as well read, "Compute the bearing power for amusement, and then guess at it for practical use." If it were true, which it is not, that any such range of factor of safety was necessary, it were better to abandon all attempts to formulate bearing power at all, as we do for bearing power of arches, and simply be sure we had bearing power enough. The examples of his rule given by Trautwine, however, show that a factor of 2 to 3 was what he had in mind as the proper factor for ordinary cases, which gives the bearing power of the above pile as 35,250 to 23,500 lbs., or, "if liable to tremors, take half." Nearly all piles are liable to tremors or their equivalent, and hence the Trautwine rule, so far as it says anything, says that our rule gives rather excessive loads for most cases. Really, however, so far as engineering records give any evidence, the Engineering News formula for safe load (we disapprove of using ultimate loads and variable factors) will never deceive by giving a load greater than the pile can safely bear, while on the other hand, for reasons which we cannot now go into, it can only rarely happen that it is either prudent or economical to put much more load on a pile than it gives. We hope to take up this whole subject shortly, and discuss it in a short series of articles, which will give all that we are able to say usefully on the subject. —Ed.)

NOTES AND QUERIES.

Jun. Am. Soc. C. E. asks for a definition of the term "Artesian well." We cannot give a better one than that in the "Century Dictionary," which is as follows:

A name given to a peculiar kind of bored well from its long use in Artois, a province of northern France. In an artesian well proper the water rises to the surface and overflows. The geological conditions permitting this are not general, since it is necessary that the region should have a more or less complete basin structure, and that there should be a series of permeable covered by impermeable beds. In the United States any deep bored well is called artesian, even if the water has to be pumped from a considerable depth. Artesian wells vary in depth from less than 100 to nearly 4,000 ft.

BUCKET FIRE EXTINGUISHER.

In many cases where small fires break out, the fire could be easily extinguished by a few buckets of water thrown on at once, and in many offices, factories, shops, stores, etc., fire buckets filled with water are kept ready for use. Objections to this arrangement are the space required, and the difficulty of placing these buckets where they are easily accessible and are sufficiently well in view to insure their not being forgotten and allowed to become empty. We illustrate this week an arrangement which strikes us as very ingenious and practicable for maintaining in the smallest possible space a supply of full fire-buckets ready for use. The arrangement would seem to have many advantages in accessibility and efficiency, as well as in the small amount of floor space required. It consists of a covered tank containing a considerable quantity of water, in which are submerged nests of fire-buckets, fitting one within the other, which can be withdrawn easily and rapidly, each bucket filling as soon as the one above it is removed. The ends of the handles slide in channels on the side of the tank, but are released by raising the handle to lift the bucket out. The water may be treated with a small amount of some disinfectant, and the tank can be concealed in an ornamental casing if desired, as for use in an office or dwelling house. The only requirement is that the

A Tank for Storing and Filling Fire Buckets.

tank shall have a capacity sufficient to fill all the buckets, with a little to spare. This fire extinguishing plant is manufactured by Messer & Thorpe, Chancery Lane, London, England. The cost is from $35 to $45, with ten 8-in. or 9-in. buckets, varying with the style of the tank. A similar plant can be improvised anywhere, however, at very trifling expense.

TAPE LEVEL.

The illustration herewith shows an application of the spirit level to secure accuracy in tape measuring. The device consists of a small spirit level about 3 ins. long, weighing only about an ounce, with springs to clamp it to the tape. It can be attached and detached instantly. The level is attached about 8 or 10 ins. from the end, and in measuring 15 ft. or less the bubble should be in the middle, with a proper

tension on the tape. For greater distances an allowance must be made for sag. For this purpose the tape must be tried on a level surface and the position of the bubble marked on the tube for distances of 25, 50 and 100 ft. In measuring, when the bubble comes opposite these marks, the ends of the tape are at the same height. When breaking chain on steep ground the level should be on the forward end of the tape in going up hill and on the rear end in going down hill. Some engineers prefer a level on each end of the tape. The device is the invention of, and is sold by, Ernest McCullough, C. E., 507 Montgomery St., San Francisco, Cal., and the price is $1.50.

THE EFFECT OF THE AERATION OF NATURAL WATERS.*

It is a very common belief that water deprived of air will deteriorate in the quality and become unfit for use and that the only way to maintain its purity is to keep it freely exposed to the air. The mountain stream which breaks over rocks and stones is thought to be a good illustration of the intimate connection between the aeration of water and its purity.

On the other hand, it is not generally known that the waters of many deep wells which we prize for their high purity, their clearness, coolness and good taste, contain no air, and have been preserved in this condition in the earth, for aught we know, for centuries. There is clearly a need of a clarification of our ideas on this subject.

Pure water, preserved from contact with organic matter, remains unchanged indefinitely. If exposed to the air it dissolves a definite amount of the gases of which the air is composed—nitrogen, oxygen and carbonic acid—the amount dissolved being dependent upon temperature and pressure. If the pressure is removed, or if the water is boiled, the gases escape, to be reabsorbed when the water is exposed to the air again at ordinary temperatures; but in no sense does the air exert any preservative action on the water or tend to keep it "fresh" or "sweet."

The condition of affairs is, however, entirely changed when water contains organic matter which is capable of undergoing decomposition. The familiar process of the change of organic into mineral matter by decomposition is one of oxidation, and the necessity of the presence of air to carry on this change is well understood. The breaking up of organic matter when oxygen is not present is one of putrification, the products of which are usually very offensive.

The analogy between the comparatively slow process of oxidation in nature and the destruction of organic matter by combustion has seemed to justify the inference that we can hasten the former as we can the latter by increasing the supply of oxygen. Acting on this assumption, it is not uncommon in water-works practice to aerate the water by causing it to flow over a series of steps, or by forcing it into the air as a fountain, or by pumping air under pressure into the distribution system. Whatever the method employed for aerating the water, the idea behind it is that the water will be thereby purified by oxidation to a degree beyond that which would take place if the water were exposed to the air on the surface only.

During the past two years numerous experiments have been made in the laboratory of the Massachusetts State Board of Health to test this theory of accelerated oxidation, and all the experiments have given negative results. The question, let it be clearly understood, is not one of supplying oxygen to an impure water, like sewage, which contains no oxygen, but this: Will an impure water, which contains at all times more or less free oxygen in solution be purified more rapidly by oxidation if the amount of oxygen is increased by spraying the water or by pumping air into it; can the natural process of oxidation be hastened by these means? It is to this question that the experiments give a negative answer. If we look for the cause of this failure to hasten oxidation by increasing the amount of oxygen we find that it rests in the inherent nature of the process, a process which is only remotely analogous to the chemical process of combustion. In combustion we have the direct chemical combination of carbon and hydrogen with oxygen, and, by varying the supply of oxygen, we can at will make the combustion slow or rapid. The case is entirely different in the oxidation of organic matter in nature. Here we have to do with the living activity of bacteria, which, in some way not fully understood, causes first the carbon and hydrogen of the organic matter and then the nitrogen to combine with oxygen. This process can only be hastened by increasing the number of bacteria, or by providing more favorable conditions for their activity. Thus we know that the temperature at which bacteria are most active differs with different species, but we have no evidence that, provided some free oxygen is present, the activity of the bacteria of decomposition is in the least affected by its amount. Here the analogy of bacterial oxidation and combustion ceases.

The first series of experiments was made to ascertain whether there was any change in the nitrogen compounds in waters under different conditions of aeration, namely:

(1.) By exposing water contained in bottles to the air of the room.

(2.) By drawing a current of air through the water by means of an aspirator.

(3.) By shaking the water with air in a bottle, in a shaking machine driven by an electric motor, the air being renewed from time to time by removing the stopper from the bottle.

(4.) By exposing the water to air under a pressure of 60 to 75 lbs. per sq. in. in soda-water siphons.

The results of the following experiments, Tables I. and II., are given as typical of several that were made:

Table I.—Results of an Aeration of Water by a Current of Air Drawn Through the Water in a Flask by Means of an Aspirator,* by Air Under Pressure, and by Shaking the Water with Air in a Bottle.

First Experiment with Cochituate Water.
(Parts per 100,000.)

	Free ammonia.	Albuminoid ammonia.	Nitrogen as nitrites.	Nitrogen as nitrates.
Original sample	.0014	.0182	.0002	.0275
After standing in open bottle for 48 hours	.0008	.0176	.0005	.0250
After aerating by current of air for 48 hours	.0014	.0170	.0005	.0250
After standing in open bottle for 216½ hours	.0036	.0158	.0002	.0250
After standing 49½ hours and then aerating by a current of air for 167 hours	.0026	.0156	.0002	.0250

Fourth Experiment with Cochituate Water.

Original sample	.0018	.0140	.0002	.0200
After standing 72 hours	.0016	.0152	.0002	.0300
After aerating 72 hours	.0024	.0142	.0002	.0200
After being under pressure of 75 lbs. for 72 hours	.0036	.0150	.0002	.0250

* The air used for aspiration was taken from outside the building. The air of laboratories where gas is burned contains enough nitrogen in the form of nitrites to vitiate an experiment of this character.

It was found that there was a very small amount of free ammonia taken up by pure water from the air in the cases of prolonged aeration.

* A paper by Prof. Thomas M. Drown, of the Massachusetts Institute of Technology, Boston, read before the New England Water-Works Association, June, 1892. From the forthcoming report of the Massachusetts State Board of Health, with some of the tables abbreviated.

Table II.—Experiments with Cochituate Water to which a Small Amount of Sewage had been Added.

(Parts per 100,000.)

	Free ammonia.	Albuminoid ammonia.	Nitrogen as nitrites.	Nitrogen as nitrates.
Original sample.....	.0780	.0300	.0000	.0250
After standing 6½ hours.	.0720	.0326	.0000	.0250
After standing 42 hours.	.0664	.0372	.0002	.0380
After standing 7 days...	.0766	.0226	.0002	.0050*
After shaking 6½ hours.	.0740	.0294	.0002	.0250
After being under pressure of 75 lbs. for 42 hours.....	.0584	.0368	.0002	.0260
After aerating 42 hours.	.0400	.0402	.0003	.0260

* This decrease in nitrates may have been possibly due to the growth of algae in the bottle.

The variations in the amounts of albuminoid ammonia and the nitrates in these experiments are in general too small to have any significance, and fail, in most cases, within the limits of accuracy of the processes used. The loss of free ammonia when the water is aerated is an instance of the driving out of one gas by another. Ammonia cannot be completely removed in this way, but when it is present in considerable amount in a water the effect of aeration by a current of air is very marked. When sewage is thus aerated a very considerable amount of free ammonia passes out with the air.

In some cases the changes in the amounts of nitrogen compounds are not easy to explain as the result of any particular treatment. The problem is a complex one. On the one hand we have the tendency of the organic nitrogen to pass into ammonia, and the ammonia to be oxidized to nitrates, and, on the other, the influence of vegetable organisms in directly assimilating the nitrogen of the ammonia and nitrates. Still, the results, as a whole, show plainly the aeration of water containing nitrogenous matter and ammonia in considerable amount has no tendency to accelerate the oxidation of the nitrogen.

In the foregoing experiments the nitrogen compounds only were investigated. The oxidation of the carbon of the oragnic matter represented by the albumnoid ammonia would have as a result the formation of more free ammonia; but, as any inference based on the amount of free ammonia might be complicated by its partial removal of aeration, a series of experiments were made to ascertain directly whether any carbon was oxidized by vigorous aeration. In this series only air under pressure was used, and the evidence of the oxidation of carbon was obtained by the "oxygen consumed" from permanganate, which oxidizes only carbon and hydrogen of organic matter, not nitrogen. Should any considerable oxidation of the carbon take place by the oxygen of the air under pressure there would be a considerable reduction of the amount of permanganate used, or the "oxygen consumed."

The results of these experiments are given in Tables III. and IV., as follows:

Table III.—Experiments on the Aeration of Cochituate Water by Air Under Pressure of 70 Lbs. per Sq. In.

(Parts per 100,000.)

	Oxygen consumed from permanganate. Without pressure, standing in open bottles.	Under 70 lbs. pressure.
Original sample	.452	...
After 24 hours.....	.421	.488
After 48 hours.....	.421	.452
After 5 days.....	.478	...

Table IV.—Experiment on the Aeration of Sewage Diluted with Distilled Water.*

(Parts per 100,000.)

	Oxygen consumed from permanganate. Without pressure, standing in open bottles.	Under 70 lbs. pressure.
Original sample (sewage, 1 part; water, 5 parts).....	.913	...
After 6 days.....	.888	.955
After 16 days.....	.682	.700

* The results of the many more experiments in both series will be found in full in the report of the Massachusetts State Board of Health, now in press.

Here, as in the previous series, we find that no more rapid oxidation goes on when the air is under pressure in the water than when the water is exposed to the air at the surface. It may be fairly concluded from the above experiments that oxidation of the elements which go to make up organic matter is a process which cannot be hastened by offering the bacteria, which are the active agents in the process, an excess of oxygen. Their activity is not stimulated in this way.

This is in accord with the interesting investigation of Dr. A. R. Leeds, who examined the water above and below Niagara Falls and found no difference in the free ammonia, albuminoid ammonia and oxygen consumed after this vigorous aeration. An interesting confirmation of the results of these experiments may also be found in the special report on Sewage Purification (Mass. State Board of Health, 1890) in which (pages 730-734) is given an account of experiments to determine the amount of air necessary for a good purification of the sewage by oxidation in intermittent sand filtration. When the atmosphere in the sand of the filter contained from 1 to 3% of free oxygen the oxidation was as complete and rapid as when 20%, or the full amount in the atmosphere, was present.

Although the strictly chemical theory of oxidation in the aeration of water will have to be abandoned it does not follow that the practice of aeration is not without good effect. It is a well known fact that one soluble gas passed in a current through water will drive out other soluble gases which may be present in it, provided there is no chemical combination between the water and gas. The same effect is accomplished by exposing water with any gas in solution to an atmosphere of another gas. Thus when we pass a current of air through water containing sulphuretted hydrogen in solution, the latter is completely driven out, and an offensive water becomes entirely odorless. This is not a case of oxidation, for a current of carbonic acid will effect the same result. In the same way a water which has temporarily a bad odor from an excessive development of algae, or infusoria, can be rendered quite odorless by sufficient aeration. Even sewage loses its odor when aerated by a current of air for many hours. In these cases the only change effected is the mechanical removal of the soluble gas which is the cause of the odor.

There is another good effect of aeration where it is accompanied by agitation of the water, namely the prevention of the growth of algae with their attendant bad tastes and odors. As is well known it is only in the comparatively quiet waters of ponds and reservoirs that this annoyance from excessive development of vegetable growth is met with. Moving waters are free from this trouble. It seems a not unreasonable explanation of the fact that an excessive growth of algae is sometimes stopped by continuous aeration to attribute it to the agitation of the water.

The most rapid means of aerating water are, first, by pumping air into it under pressure, the excess of air escaping when the pressure is removed; second, by breaking it into spray by providing a series of falls, or by means of a fountain jet, or, third, by a fall, in a pipe of similar construction to an injector. But these violent methods of supplying oxygen are not necessary if there is circulation in the water of a pond or reservoir whereby all the water in turn is exposed on the surface to the atmosphere.

On the advent of warm weather in the spring of the year the water of any pond over 20 ft. deep may become stagnant at the bottom, and if the water contains decomposible organic matter the oxygen in solution is soon consumed and no more can be obtained from the atmosphere. Under these conditions this stagnant layer becomes very foul from putrefaction. This matter has been very fully studied in the case of Jamaica Pond, Boston, and is described in the report of the Massachusetts State Board of Health on the Examination of Water Supplies, 1890, and also in the forthcoming report for 1891.

But the water in the stagnant layer does not become foul unless there is decomposible organic matter present. Thus, in Basin 4 of the Boston water-works, which was carefully prepared for the reception of the water by the removal of all soil and vegetable matter, and is supplied with a brown swampy water from a watershed almost entirely free from population, the water is good at a depth of 40 ft., because the water contains very little organic matter with a tendency to decomposition.

The water is permanently stagnant during the summer months only below a depth of about 20 ft., because it is turned over by strong winds to this depth in ponds of 100 to 200 acres area. But water may be temporarily stagnant at a less depth in the absence of strong winds. In some ponds we have found oxygen to be absent at a depth of 10 ft., and the water to contain much free ammonia and other products of decomposition which were absent in the layers nearer the surface.

In cases where it would be possible to bring about a circulation of an entire body of water during the warmer months, so that the lower layers would be brought to the surface and stagnation prevented, we would have effective aeration of the water with the prevention of the accumulation of products of decomposition.

In the case of ground water it is now well understood that the more directly from the ground it is supplied to the consumer the more acceptable it is. It needs no aeration. In fact, its storage in open reservoirs results often in the conversion of a cool, clear, palatable water into one which is repulsive to sight, taste and smell.

There is, however, one class of ground waters, not infrequently met with, which are only fit to use after they have been exposed to the air; namely, waters which contain considerable iron in solution in the form of protoxide. These waters deposit iron oxide on standing, owing to their absorption of oxygen from the air. Aeration in connection with settling basins or filter beds might make waters of this class available for general use.

To resume:

(1). The oxidation of organic matter in water is not hastened by vigorous agitation with air or by air under pressure.

(2). The aeration of water may serve a useful purpose by preventing stagnation, by preventing the excessive growth of algae, by removing from water disagreeable gases, and by the oxidation of iron in solution.

A SYMPOSIUM ON THE USE OF STEEL FOR RAILWAY BRIDGES.

The varying opinions as to the use of steel in railway bridges which were expressed in the discussion on Mr. J. A. L. Waddell's recent paper before the Am. Soc. C. E.* have been brought to our attention by Mr. Henry B. Seaman. We reprint them herewith, as they illustrate very well the conflicting ideas concerning structural steel which are prevalent at the present time. It should be rememberd, however, that only about one-fourth of those who contributed to the discussion made any reference to the use of steel. Now, as in discussions members are most apt to dwell upon points concerning which they disagree with the writer of the paper, and to pass over points on which they agree with him, it is perhaps fair to conclude that a majority of those who did not discuss the use of steel were in accord with Mr. Waddell. Among those who thus discussed the paper without commenting on Mr. Waddell's assumption that steel is soon to replace iron in bridge structures, were such prominent engineers as Thos. C. Clarke, Geo. F. Swain, J. B. Johnson, Mansfield Merriman, L. F. G. Bouscaren, Frederick H. Smith, Benjamin Douglas, A. J. Swift, O. F. Nichols, and others.

We reprint as follows the portion of the discussion referring to the use of steel:

J. A. L. Waddell.—We will take the bold step of assuming that in the near future the material for the metal portions of railway bridges will be exclusively steel. This step is warranted by the fact that today mild steel is practically as cheap as iron and that it is fully as reliable.

J. M. Johnson.—In my judgment all specifications should contain requirements, stating under what conditions both iron and steel could be used, leaving it to the engineer to determine which would be the more suitable, in any given case. The author leans very strongly toward steel, and perhaps with reason; but I would not be inclined to accept, as he does, the drift test as indicating where steel could be substituted for iron. A quality of steel that could be subjected in thin sheets to any sort of rough usage without perceptible injury, would probably have its strength seriously impaired if treated in the same way, the thickness being increased to the maximum of the rolls. When steel is used in lieu of iron, in addition to the general physical and chemical requirements, the specifications should, in my opinion, contain a clause limiting the maximum thickness of metal.

Gustav Lindenthal.—Mr. Waddell maintains that mild steel will in the future be used exclusively for all metal railway bridges, because it is practically as cheap as wrought iron and fully as, or more, reliable. In this respect the bridge engineer is dependent on the progress in the metallurgical arts of making wrought iron and steel. The improvements of the last ten years were altogether in the manufacture of steel, and none in that of wrought iron, which is still made by the old laborious and costly process of hand puddling. But the time does not seem to be far distant when wrought iron will be made by some improved metallurgical process in larger masses and at a great deal cheapened cost, and it would be difficult now to predict whether wrought iron or mild steel in that case would be more largely used. In the use of steel for structural purposes, the preponderance of evidence favors the Siemens-Martin open hearth process as against the Bessemer made steel. The mild steels will probably always be used for plates and for heavy members made of large single pieces of metal.

Wm. H. Burr.—I heartily indorse all that Mr. Waddell states in regard to the use of steel. Whether it will be the material to be used in all bridge spans, both short and long, is simply a question of cost. Whenever a short span steel bridge can be produced at the same or less cost than one of wrought iron, the steel will certainly displace the latter. I am aware that my confidence in the use of steel is not shared by many members of the society, but I am forced to my convictions by my experience with the metal. I have frequently subjected steel plates and rivets to almost every conceivable manner of abuse by hammering at blue heat and when cold, with the invariable result of increasing my confidence in and respect for the metal. I am now speaking of steel with an ultimate resistance of not over 65,000

* "Some Disputed Points in Railway Bridge Dealgning." See Eng. News, Dec. 12 and 26, 1891.

lbs. per sq. in., produced by the open hearth process, and with phosphorus not more than about 0.06 or 0.07%. It is true that I have seen counter-sunk heads torn off by a very dull flogging chisel under the blows of heavy sledges, but I have also seen the best wrought iron rivets torn off in the same way with a considerable less number of blows from the same sledges.

The processes for producing structural steel are now so completely under control that it may be produced with the same uniformity as, or greater than, that of wrought iron, in the same shapes or bars. The effects that are liable to be produced by the various stages of shop processes, and their influences, are so well understood at the present time that I know of no reason why steel members should suffer under them any more than those of wrought iron; and numberless experiments upon the effect of punching have shown that structural steel of the grade described is less injured than the best of wrought iron used for structural purposes. It is true that cracks must be guarded against, for when once started, if they receive no further attention, their limits are indeterminate; but it is quite true that no process of shearing or punching with tools in anything like respectable condition will start such cracks, and it is not by any means difficult to discover them, even when punching or shearing abuse has brought one into existence.

In the miscellaneous exigencies of railway and machinery practice it has been found that when a metal is demanded that shall possess the longest life under the most severe loading and use, wrought iron must be displaced and steel used; and the results of my experience have convinced me that resort may be wisely made to the same material of proper grade in bridge construction. If the so-called mysterious fractures which occur in wrought iron, and in the best grades of that material, were as much talked about and as thoroughly written up as those occasional ones in steel, I have no doubt that general confidence in the latter material would be much less impaired than it is at present. I have known as many failures of wrought iron members for various purposes which certainly ought to be put on the same category as those so-called "mysterious failures" in steel, that I think fibrous wrought iron must be classed as at least as uncertain as homogeneous steel. It matters little whether from the producer or the puddling furnace, to the finished bridge member, steel or iron requires the greater amount of inspection; in either case only the most ordinary and reasonable scrutiny is required.

The subject of permissible working stresses for steel is one which can scarcely be properly covered within the limits of this discussion; but I would say approximately that for the grade of structural steel under consideration the working stresses should not be more than 20 to 25% in excess of those for wrought iron.

Edwin Thacher.—I doubt whether steel will ever be used in bridge work more extensively than it now is. There is no economy in reamed steel for small trussed spans. Steel of the mildest grades is less reliable than iron. In the dropping or overturning of girders in wrecks, careless handling, or abuse of any kind, steel suffers much more severely than iron. Steel is unquestionably safe under ordinary conditions of stress, but I do not believe it can ever be made the equal of iron under all conditions.

I would never use unreamed compression steel of any grade under any circumstances. It may stand the drift test and bend double upon itself, yet in the careless upsetting of a girder, crack like glass. As regards the use of steel, the question as to the most desirable grade to use has more interest to me than any other: if very mild steel is used in compression, the cost of reaming prevents in a great measure its economic use as compared with iron, and unless some very decided saving can be effected by its use I would much prefer iron. I have favored, both for tension and compression, a steel having a mean ultimate strength of about 70,000 lbs., although I believe a majority of engineers favor a lower grade. I am in favor of the grade mentioned for several reasons; its use effects a material saving in the cost of structures; it can be furnished of uniform quality; its elastic limit and reduction of area are superior to iron, and in cold bending it is nearly or quite the equal of iron, and when annealed after forging and when reamed after punching, it appears to me to be as safe as the milder grades. If this is true, why throw away a strength of 10,000 lbs. per sq. in.? and if not true, I would be glad to hear some good and substantial reasons why. I would be glad to hear an expression of opinion on this important question of economy.

Robert Moore.—Referring to Prof. Waddell's remarks upon the use of steel in bridge work, the writer fully agrees with him that, except for screw bolts and minor members, it should be insisted upon for all first class work. When the utmost economy of time and money is demanded, the writer is sometimes forced to allow the use of iron—excepting for eye-bars, pins, rivets and connecting angles—but he does it with great reluctance. But in using steel he differs from Prof. Waddell in believing that the reaming, or, better still, the drilling of rivet holes after the parts are assembled is something that ought always to be required. This should be done not only as a precaution against injury to the metal and consequent fracture, but more as a means of securing smooth and closely matched holes which the rivets can completely fill. In holes for field rivets, where tight work is so hard to get, the reaming is a matter of much importance, for iron no less than for steel.

Palmer C. Ricketts.—I do not doubt that the time will soon come when steel will wholly replace wrought iron, not only in bridge work, but in almost all structures and machines in which such iron is now used. It seems to me, though, that there are few engineers who would care at present to use this material only in bridges, in exactly the same way that wrought iron is used—with holes punched and not reamed in tension as well as compression members—and unless it is so used it cannot be said that it is practically as cheap as iron, for spans of ordinary length at least. But even though wrought iron should not be ruled out by the specifications, there hardly seems to be much doubt about the advisability of using steel properly throughout, even at an increased price.

Jno. A. Fulton.—In test specimens we may require an elongation of 20% and ability to stand a sharp bend without sign of fracture, but in bridge wrecks we do not find any such elongation nor any such bending. Doubtless, the difference in treatment is the cause of the difference in results. Attempt to cut ordinary molasses "taffy" with a knife or to twist it or pry it apart and the task is quite troublesome, but strike it with a light hammer and it is found to be about as brittle as glass. The former experiment shows how we test material, the latter shows how we use it. If some one would devise a scheme for testing bridge members which would treat them about as they are treated in a bridge, the results of such tests for elastic limit and for ultimate strength would be exceedingly valuable to the bridge designer, but they might differ somewhat from the values generally assumed.

Samuel Tobias Wagner.—The writer is very glad to see that Mr. Waddell has advanced his opinion regarding the unnecessary reaming of rivet holes of mild and medium steel which will stand the enlarging of the rivet hole 25% by means of the drift test successfully; and hopes that more of the members will put themselves on record in the same way. It has always seemed an insult to good metal to require reaming when the quality of the metal is such that no practical benefit is derived from it. The line, however, where the reaming becomes necessary should be carefully observed, and probably Mr. Waddell's requirements meet it as well, if not better, than any other way.

Now that eyebars are manufactured of widths up to and including 10 in., it is advisable to use wider bars for long panels than was formerly the custom, and at the present time this is being largely done. By using a wider bar it is possible also to reduce the number of bars in a panel, thickness of each individual bar, the bending moment on the pin and consequently its diameter and length. In making bars of the largest sections, special care should be paid to the tests, as special arrangements must be made by the manufacturer to cast special ingots, or use larger piles to insure the requisite amount of work in the rolls upon the metals. Steel bars of the larger sections especially are much more desirable in every way than iron, both in reliability and finish.

Henry R. Seaman.—The assumption that "in the near future the material for the metal portions of railway bridges will be exclusively steel" seems to me a little premature. The objections to its use have not yet been removed; and although the development of its manufacture has enabled its production with as much uniformity and economy as that of wrought iron, it still has the same objectionable structure. The objection to the use of steel in railway bridges is, that it resembles a refined, ductile, homogeneous cast iron, rather than a fibrous wrought iron; and although recent practice has gradually reduced the carbon until its composition approaches more nearly that of wrought iron, it has never yet been given a fibrous structure. It is to this fact that the present objection to its use is due.

Steel is objectionable because the least scratch, so fine as to be imperceptible to the closest inspection, may in time, under vibratory strains, lead to the destruction of the member. No inspection can be close enough to avoid this danger, and the reduction of the hardening elements does not eliminate it. This characteristic is due to its homogeneous structure rather than to its chemical composition.

Tests of steel under constant strain are of no value whatever as a criterion for its use in railway bridges. The development of a scratch under a single application of load would not be noticed. The chief care in the maintenance of iron bridges, and the one to which the closest inspection is directed, is the detection of flaws in details. A member rarely fails because of overstrained material. There are members in bridges which have been in use for years, with strains far exceeding those usually allowed, and which are safe; but there are details which, to all outward appearance, have been perfectly sound, but have suddenly developed flaws which, had they not been detected before the passage of a train, would have resulted in a bridge failure. It is for this reason that engineers hesitate to adopt a material the character of which favors the development of such flaws.

The general use of steel would seem objectionable for the reasons mentioned, but to cite the drifting test as an authority for its use without reaming would seem worse than to depend upon the single application of a load to show the development of slight flaws. "The standard drifting test" is of value only in discovering hard spots in the immediate vicinity of the hole, but cannot detect cracks or scratches caused by punching, the presence of which renders reaming necessary. Enlarging the holes by drifting forces the metal back upon itself, and tends to close rather than to open these defects. It may indicate soft material, as would also a tension test, but as a demonstration that soft steel does not require reaming the drifting test is a delusion.

The use of steel rails is sometimes cited as an argument for the adoption of this material in railroad bridges. When bridges receive the same incessant inspection in all their details, or when bridge members can be replaced as quickly and with as little expense as can a broken rail or splice bar, and when the failure of a bridge is attended with nothing more serious than a derailment—then may the general use of steel be advocated for railway bridges; but until this is true it is well to proceed with caution.

J. C. Bland.—Regarding Mr. Waddell's assumption (page 21 of this paper) "that in the near future the material for the metal portions of railway bridges will be exclusively steel," it may be remarked that the most important railroad in the country still refuses to use steel in its structures, even, I understand, to the exclusion of steel eye-bars; and that a large line west of Pittsburg, by implication, from reading its specification, contemplates the use of iron structures to the exclusion of steel. Until such railroads can be shown the "errors of their ways," I fear Mr. Waddell's "near future" will be somewhat remote.

G. H. Blakeley.—The testing of mild steel under many conditions and its subjection to all kinds of rough treatment have convinced the writer that it is safe to use such steel with the same processes of manufacture as are in vogue for wrought iron. Unless the steel is of very high tenacity the precaution of reaming the rivet holes is not needed much more than it is for iron, and indeed the milder grades of steel show less injury by punching than does wrought iron. In either metal the reaming is beneficial. The notion that mild structural steel is brittle, and like the material used for tools, is being gradually displaced by a better knowledge; and there is a more general recognition of the fact that the structural steel of to-day, produced by the open-hearth process, is not properly steel at all, but more or less a homogeneous wrought iron in which the absence of slag and cinder prevents the development of fiber in the processes of rolling.

A thin narrow strip of soft steel with a hole punched in it can be bent over until the faces are nearly in contact, without cracking through the line of bend which passes through the punched hole. This cannot be done with iron except in extremely rare instances. The time was, not long since, when it was scarcely thought possible to produce steel with a less percentage of carbon than 0.30%. Now it is easily produced with only 0.12% or less. The experiments on the injurious effects of punching have been principally made upon this higher steel and very few upon the milder steel of more modern production. More extended acquaintance has brought increased confidence in the capacity of mild steel for structural purposes, and there is now as much steel used in construction with the same process of manipulation as wrought iron as there is reamed and planed.

It is, however, not advisable to use steel of high ultimate strength without reaming the punched holes. The limit above which reaming should be required should be placed at about 70,000 lbs. Steel of this quality will stand the drifting test of an enlargement of 50% at least, and the writer knows of steel of 80,000 lbs. ultimate strength which has withstood an enlargement of 100%. The drifting test is a valuable adjunct in the way of testing, but it should not be made the final test.

J. A. L. Waddell.—I am glad to have my remarks on the exclusive use of steel for bridges indorsed by so high an authority as Mr. Burr, although Mr. Thacher, another high authority, differs with us both on several important points. Mr. Lewis' paper on "Soft Steel in Bridges,"* before referred to, throws a good deal of light upon the subject. It is to be hoped that the discussion of this important matter will be continued, although if it is not, the effect in my opinion will be only a very short delay in the abandonment of wrought

* Eng. News, March 26 and April 2, 1892.

iron for bridges. I am in favor of using medium steel for all parts of bridges, excepting for rivets, for which I would use soft steel. Answering Messrs. Gates and J. M. Johnson, I would state that I failed to specify the grade of steel for two reasons; first, medium steel was understood, as that is what nearly all bridge builders are now using; and, second, my paper was not intended (and, in fact, was not permitted) to be a specification. In regard to the reaming of steel, I am quite ready to be convinced of my error by a general consensus of opinion; mine on this point, I must acknowledge, is mostly second-hand. It is evident that reaming is a good precaution; but the question is, "Is it worth the cost?" If it be decided that medium steel should be reamed, I think that wrought iron also should be required to receive the same treatment.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XIX.

THE SCHOOLS OF MECHANICAL ENGINEERING.

The first mechanical engineering graduates of which we have any record graduated in 1868, which means that the first classes were formed in 1864-5, or immediately after the critical part of the war. In that year three colleges, Rensselaer, Yale and the Mass. Inst. Tech., graduated classes, the two latter of only 1 each, and Rensselaer a class of 5. Thus the latter college took the lead in mechanical as well as civil engineering instruction. Having but narrow means, however, and seeing Stevens and other mechanical engineering schools organized about that time, Rensselaer very wisely abandoned that new field to cultivate its original field of civil engineering more completely, after graduating four classes in mechanical engineering. If we are correctly informed, the foundation of the Stevens Institute to teach mechanical engineering only was the chief reason why the R. P. I. abandoned that field so soon after entering into it.

The astonishingly rapid growth of mechanical engineering instruction is shown again in the following contrast by quinquennial periods:

	No. C. E. graduates.	No. M. E. graduates.
1860-64, 5 years	153	...
1865-69, 5 "	289	15*
1870-74, 5 "	657	101
1875-79, 5 "	1,048	270
1880-84, 5 "	902	382
1885-89, 5 "	1,292	911
1890-92, 3 "	1,014	1,119
Total	5,355	2,778

* Two years, '68-9.

The growth of instruction in electrical engineering separately from mechanical engineering, we are unable to show with any accuracy. In fact, it is not yet possible to do so with any approach to accuracy, if it ever will be, for the reason that some of the best schools decline to treat electrical engineering as a proper subject for a separate course, but rather take the position that such a course must be at best "nine-tenths mechanical engineering to one-tenths electrical," and therefore make it a mere sub-department of the regular mechanical course. Of these schools Stevens is by far the most prominent, but there are a number of others.

It is obvious that there is much to justify this position, but it is to be hoped that every engineering school will at least recognize distinction enough to report separately those who do and those who do not take the course in mechanical engineering with intent to become electrical engineers. By comparison of Stevens with Cornell we may infer that somewhat over half of the Stevens graduates are aiming at electrical practice, but such an inference may be quite erroneous.

We have reports of electrical graduates separate from the mechanicals for 1891 and 1892 only, and not even this for a few of the colleges shown in Table XVIII. The following little table gives such separate returns as we have for these two years, and covers most of the colleges listed which had graduates in either. It will be seen that in one year, 1891-2, the number of mechanical graduates increased by 33 in 1892, or 18.3%, while the number of electricals increased 59, or 49.5%.

We may frankly confess that in beginning this investigation we had no idea that instruction in electrical engineering had become such a considerable fraction of the whole (nearly one-quarter), or we should have made an effort to gather separate statistics of its rise and progress, from the beginning.

No.	College.	1891. M. E.	1891. Elec.	1892. M. E.	1892. Elec.
3	Yale	35	15	34	15
6	Univ. Mich.	4	3	4	5
9	Columbia	5	5	9	6
11	Mass. Inst. Tech.	26	23	25	36
12	Lehigh	6	7	10	9
13	Univ. Va.	1	..	..	..
15	Tufts	..	7	..	8
18	Wash. Univ.	..	..	4	..
21	Worcester P. I.	17	3	21	1
22	Ala. P. I.	..	..	..	2
23	Me. Agr. Coll.	6	..	8	..
24	Iowa Agr. Coll.	6	..	4	4
25	Univ. Pa.	(8)*	..	(3)*	..
26	Stevens Inst.	(45)*	..	(39)*	..
27	Univ. Wisc.	7	..	7	1
30	Cornell Univ.	24	28	35	44
32	Univ. Cal.	6	..	2	..
34	Univ. Minn.	1	2	2	4
34	Rutgers.	..	3	..	2
36	Univ. Ia. (Electrical course 2 years old.)				
38	Univ. Ill.	7	..	4	..
41	Tex. Agr. Coll.	6	..	7	..
42	Univ. Neb.	..	2	..	2
44	W. Univ. Pa.	..	..	2	..
45	Pa. State Coll.	3	3	2	3
46	Purdue.	6	2	5	12
47	Rose Pol. Inst.	..	14	1	22
50	Mich. Agr. Coll.	6	..	7	..
51	Ga. Sch. Tech.	8	..	20	..
	Total	180	117	213	176

* These schools treat electrical engineering as merely a sub-department of mechanical engineering, and do not separately report electrical graduates, though giving careful instruction in that branch. The same is true of a number of other schools which have arranged to give careful instruction in electrical engineering.

Notes and Corrections to Tables XIII., XIV. (issue of Aug. 4) and Subsequent Tables of Graduates to Date.

2. HARVARD: Lawrence Scientific School. Mr. J. Foster Flagg calls our attention to the fact that the number of graduates in 1855 and 1860 was incorrectly given in Table XIV., though it was correctly stated in the detail table for this school (Table IX.) published May 19. The number of graduates in 1855 should have been 8, not 4, and in 1860, 4, not 3. The error arose from the fact that in the original report only the total number of graduates up to 1855 and between 1855 and 1860 was given, so that in the original tabulation a mean yearly number had to be estimated for those two years, which escaped correction by more precise information. The complete list of graduates in engineering to 1861 inclusive, as already given, is as follows:

'53	'54	'55	'56	'57	'58	'59	'60	'61
4	9	8	10	10	8	3	4	5

3. YALE: Sheffield Scientific School. Mr. Horace Andrews favors us with the following information:

In reference to your table of p. 112 (Aug. 4) I can give some amendments for the Sheffield Scientific School graduates. Unfortunately the so-called University Catalogue seems to be still published in the interest of the academical department chiefly, and it is impossible from it or from the triennial catalogue to derive any information as to the courses of study pursued by the graduates. I presume the S. S. S. still makes annual reports to the legislature. I have these for 1868 to 1871 and 1871 to 1875 and for 1885; and from these it appears that the graduates in engineering were as given below. I may mention that in the class of 1871 (my own) there were no dynamic engineers, as the course was not established till about 1871, when Prof. Wm. P. Trowbridge was appointed a professor of dynamical engineering. Of the graduates of 1871, two subsequently took the degree of Dynamical Engineer and hence should properly be classed under that head.

Class.	Mining Eng.	Dynamic Eng.	Civil Eng.	Total.
1868	2	1	7	10
1869	3		11	14
1870	1		15	16
1871		2	13	15
1872	Missing.			
1873		10	9	19
1874		6	17	23
1875		9	22	31
1885		16	17	33
Total for the 8 years mentioned				161
Total as given in Engineering News				111
Error				50

I am very sorry you have been so misinformed. A letter to Prof. Geo. J. Brush, to Prof. Wm. H. Brewer or to Prof. Aug. J. Du Bois should give you a list of the engineering graduates that could be relied on.

The above letter doubtless explains how the errors arose in our original table, the information for which

TABLE XVIII.—TOTAL NUMBER OF GRADUATES FROM COURSES OF MECHANICAL ENGINEERING (INCLUDING ELECTRICAL) FOR ALL OF THE FIFTY-TWO COLLEGES LISTED IN TABLES XIII., XIV., HAVING GRADUATES FROM SUCH COURSES, FOR EACH YEAR SINCE THEIR FORMATION.

School:	1868	1869	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	1891	1892	School:
1. Rensselaer	5	5	8	4																						Rensselaer.
3. Yale	1	....	..	2	(4)	10	6	9	(9)	(7)	(7)	(7)	(9)	(9)	(9)	(9)	(12)	16	(20)	(18)	(21)	(25)	(29)	50	49	Yale.
6. University of Mich.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	1	6	7	6	7	7	9	University of Mich.
Totals, Group A..	6	5	8	6	4	10	6	9	9	7	7	7	9	9	9	10	12	17	21	24	28	26	36	57	58	
9. Columbia	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	6	Columbia.
11. Mass. Inst. Tech.	1	2	2	2	1	2	4	6	9	6	2	8	....	5	5	7	6	8	33	25	42	40	45	49	61	Mass. Inst. Tech.
12. Lehigh	....	1	2	1	....	2	..	....	3	....	5	2	2	1	....	7	4	4	6	12	14	12	9	13	19	Lehigh.
13. Univ. of Va.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	Univ. of Va.
Totals, Group B..	1	3	4	3	1	4	4	6	12	6	7	10	2	6	5	14	10	12	39	37	56	52	54	68	86	
15. Tufts	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	5	1	3	7	7	8	Tufts.
16. Univ. Ga.	....	....	....	....	....	1	2	1	....	1	....	....	....	....	....	1	....	1	1	1	1	....	1	....	1	Univ. Va.
18. Washington U.	....	....	....	....	1	....	....	....	....	....	....	2	..	2	....	....	1	....	1	2	4	....	2	....	4	Washington U.
20. Kans. Agr. C.	....	....	....	(4)	(2)	(1)	(4)	(1)	(4)	(6)	(3)	(6)	(5)	(6)	(3)	(8)	(12)	(10)	(14)	(14)	(15)	(17)	(18)	(26)	(29)	Kans. Agr. C.
21. Worces. Poly. Inst.	....	....	....	6	4	10	9	11	4	11	9	12	11	12	17	11	14	17	18	17	21	23	18	20	22	Worces. Poly. Inst.
22. Ala. Poly. Inst.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	Ala. Poly. Inst.
23. Me. Agr. Col.	....	....	....	....	....	....	....	3	5	4	1	4	....	3	5	1	1	4	3	4	6	2	15	6	8	Me. Agr. Col.
24. Iowa Agr. Col	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6	8	Iowa Agr. Col.
Totals, Group C..	....	....	....	10	7	12	15	16	13	22	13	24	16	23	28	24	28	32	39	43	48	45	61	65	73	
25. Univ. of Penna	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	8	3	Univ. of Penna.
26. Stevens Inst. Tech.	....	....	....	....	....	1	3	9	16	9	22	15	6	16	12	19	40	36	32	30	38	36	39	45	39	Stevens Inst. Tech.
27. Univ. of Wisc.	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	3	5	5	4	4	5	4	3	7	8	Univ. of Wisc.
30. Cornell Coll., M. E.	....	....	....	....	....	....	3	3	4	2	5	5	5	5	6	7	10	7	10	19	24	33	60	52	79	Cornell Coll., M. E.
32. Univ. of Cal.	....	....	....	....	....	....	....	....	....	2	1	3	....	6	3	....	1	....	..	2	3	2	4	6	2	Univ. of Cal.
33. Univ. of Kans	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	....	1	Univ. of Kans.
34. Univ. of Minn.	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	1	....	1	....	1	2	....	3	3	6	Univ. of Minn.
35. Rutgers	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	2	Rutgers.
38. Univ. of Ill.	....	....	....	....	....	....	....	....	....	....	4	1	2	1	5	1	1	5	5	5	2	3	11	7	4	Univ. of Ill.
39. Univ. of Cinc.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	(1)	Univ. of Cinc.
Totals, Group D..	....	....	....	....	....	1	6	12	20	13	33	24	14	29	26	31	57	54	51	61	74	78	123	131	145	
41. Texas Agr. Col.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	5	3	3	6	7	Texas Agr. Col.
42. Univ. of Neb.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	2	2	Univ. of Neb.
44. W. Univ. of Pa.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	W. Univ. of Pa.
45. Pa. State Coll.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	6	5	Pa. State Coll.
46. Purdue	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	5	1	5	6	4	8	17	Purdue.
47. Rose Poly. Inst.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	15	8	10	4	10	14	23	Rose Poly. Inst.
50. Mich. Agr. Coll.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	6	9	6	7	Mich. Agr. Coll.
51. Ga. Sch. of Tech.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	8	20	Ga. Sch. of Tech.
Totals, Group E..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	20	9	23	20	29	50	83	
Grand totals	7	8	12	19	12	27	31	43	54	48	60	65	41	67	68	79	107	117	170	174	229	221	303	371	445	

was official from each college with the sole exception of Yale. We regret that our correspondent could not have furnished us with the complete list. As it is we use the figures which he gives so far as they go, adding estimates in parenthesis for the intermediate years, which may be considerably in error for this particular college, but which keep the totals about right.

22: Alabama Polytechnic Institute. The following corrections should be made in the tables giving number of civil engineering (and other) graduates: 1892, 6 (5 civil, 1 mining); 1888, 6; 1890, 5; 1891, 12; 1892, 22 (including 1 in electrical engineering). We may note that in all our tabulations no attention is paid to post-graduates, as this would, in general, be counting men twice over.

17: LAFAYETTE COLLEGE, Easton, Pa. The following is the correct number of graduates from the Pardee Scientific School of this institution since its foundation: 1870, 2; 1871, 5; 1872, 5; 1873, 8; 1874, 11; 1875, 7; 1876, 16; 1877, 15; 1878, 8; 1879, 4; 1880, 9; 1881, 5; 1882, 4; 1883, 6; 1884, 14; 1885, 10; 1886, 10; 1887, 12; 1888, 8; 1889, 8; 1890, 11; 1891, 21; 1892, 10; total, 207.

38: UNIVERSITY OF ILLINOIS. In Table XIII. (p. 114) the word "civil" should be stricken out of the name of the College of Engineering, and the university itself is in Urbana, Ill., though its post office is correctly given as Champaign, Ill.

The following notes refer to colleges of engineering which were not included in Tables XIII., XIV., for lack of returns or otherwise, but are believed to have been fully entitled to inclusion, as having courses in engineering quite as good as at some of the colleges which were included.

UNIVERSITY OF ALABAMA (University, Ala.): The rising university should have had its graduates included, except that returns were not available. It graduated 4 (B. C. E.) in 1890, and 7 in 1891.

COLUMBIAN UNIVERSITY: Corcoran Scientific School (Washington D. C.): This school has for some years past graduated small classes in engineering with the prospect of largely increasing its classes from 1893 on, as noted in our issue of April 21.

DELAWARE COLLEGE (Newark, Del.) had 2 graduates in engineering in 1892.

STATE COLLEGE OF KENTUCKY (Lexington, Ky.) graduated 4 (C. E.) in 1892. We have no information as to earlier graduates.

ST. JOHN'S COLLEGE (ANNAPOLIS, MD.) graduated 1 each in 1888-9-90, in mechanical engineering. We have no later reports.

OHIO STATE UNIVERSITY (Columbus, O.): By an unfortunate omission due to lack of records, this university was not included in our tables, though it has classes in civil, mechanical and mining engineering, and has graduated classes of 1 to 10 in every year from 1880 to 1892 inclusive, the total number ('92 somewhat doubtful) being 60, of which 22 were "civils," as shown in the following detail list.

	'80	'81	'82	'83	'84	'85	'86	'87	'88	'89	'90	'91	'92
Civil,	..	..	..	1	1	1	3	2	4	1	2	2	(5)
Mech.,	1	..	1	1	1	2	1	2	4	1	3	2	(3)
Mining,	1	1	..	2	1	1	4	1	2	2	..	..	(1)
Total,	2	1	1	4	3	4	8	5	10	4	5	4	(9)

SYRACUSE UNIVERSITY, Syracuse, N. Y. This university had a course in civil engineering from 1875 to 1889, with 2, 7, 2, 0, 1, 0, 3, 0, 2, 2, 3 and 2 graduates in the successive years, when the course was abandoned; a total of 24 graduates in all, not included in Table XIV., etc. This is the only case that we know of in the country where a fully established engineering school has been abandoned.

UNIVERSITY OF THE CITY OF NEW YORK.—A partial list of the graduates in civil engineering from this university shows 74 graduates in all, from 1867 (when we believe the first were graduated) to 1892. In 1888, 8 were graduated, and in 1893, 3. No graduates from this university were included in our lists, for lack of returns.

UNIVERSITY OF NORTH CAROLINA (Chapel Hill, N. C.): This university, graduating 4 men in 1891 and 2 in 1892 as "Bachelors in Engineering," should have been included in Tables XIII. and XIV. It is making an earnest effort to further strengthen and improve its course, which is already a pretty thorough one, and bids fair to become an important school.

HAVERFORD COLLEGE (Haverford, Pa.): In the four years 1887-90 this college graduated 1, 3, 2 and 4 "Bachelors of Engineering." We have no later return.

POLYTECHNIC COLLEGE OF PENNSYLVANIA. We are in receipt of the following inquiry:

Sir: In your list of engineering schools of the United States I fail to find any mention of the Polytechnic College of Pennsylvania, and I am curious to know why the same has been omitted. Its graduates are scattered all over the world, and I feel that justice is due to them. Dr. A. L. Kennedy, of Philadelphia, was at its head for a number of years, but I am unable to state if the institution is now in existence. Respectfully,

Hiram J. Slifer,
Class of 1876.

Milwaukee, Wis., Aug. 8, 1892.

We have no knowledge of this institution other than that given in our correspondent's letter. It is in none of the lists of the Bureau of Education, so far as we have discovered.

VANDERBILT UNIVERSITY (Nashville, Tenn.): This important and growing university has had 4 to 5 graduates in engineering yearly for a number of years. We regret the omission of its returns from our tables, caused only by the fact that we had none.

VIRGINIA MILITARY INSTITUTE (Lexington, Va.): This institute has graduated the following classes in civil engineering (except that 5 graduates in 1889 and 1 in 1871 were in mining):

'69	'70	'71	'74	'75	'85	'86	'87	'88	'90
6	6	5	1	1	1	1	3	2	2

For 1891 and 1892 we have no report, but we understand that this is otherwise a complete list.

VIRGINIA AGRICULTURAL AND MECHANICAL COLLEGE (Blacksburg, Va.) in 1888-'90 had 3, 2, 1 graduates in mechanical engineering. We have no later reports.

THE BREAKAGE OF A STREET EMBANKMENT IN ST. PAUL.

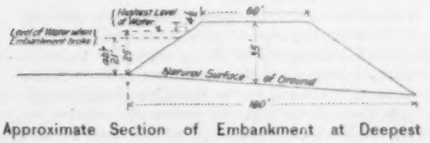
The disaster in St. Paul, Minn., on Aug. 3, caused by the breakage of an embankment behind which a large volume of water had accumulated, furnishes interesting evidence as to the strength (or rather lack of strength) of an ordinary earth fill to resist the pressure of water, and it should serve as a warning to engineers to make sure of ample drainage in the construction of every embankment behind which water may collect. We gave some particulars of the disaster and its causes in our issue of Aug. 11, but its importance is such that we give space to the following fuller description abstracted from the report of the testimony at the coroner's inquest, given by the "Pioneer Press:"

The embankment which failed was made in the fall of 1889, and carried Page St., which runs east and west, across a ravine running northwest and southeast. The embankment was 300 ft. long, 60 ft. broad on top, and 160 ft. at the bottom at the deepest point of the ravine, where its height was 35 ft. It was built principally of clay, with some sand and gravel. A box drain 2 ft. wide and 3 ft. high was the only provision for drainage. This became choked with sand and a small amount of water accumulated behind the embankment last winter. Heavy rains in July rapidly raised the water, and the city engineer ordered the drain opened to draw it off. The Street Commissioner spent two or three days floating about the pond on a raft trying to find the box drain by punching with an iron rod. After it was located a timber crib 6×8 ft. was built and a shaft was sunk from it down through the edge of the fill. When work was stopped on Tuesday afternoon, July 26, the shaft was down within 6 ft. of the top of the drain. That night came a great rain-storm, and in the morning the top of the crib was submerged and the water was within 4½ ft. of the top of the fill. Work on the crib was abandoned, and it was attempted to drain the water out by a siphon.

A trench was dug in the natural earth surface beyond the end of the fill about 12 ft. deep and continued until a point was reached about 20 ft. from the water on the other side. Hose was run over the roadway from the pond to this ditch, and on July 20 the work of siphoning began, the greatest depth of water being then about 25 ft. By the evening of Aug. 3 the water had been lowered 3 or 4 ft.

After the storm of July 26 watchmen were kept on the fill all the time with instructions to notify the people below if the embankment showed signs of giving way. The watchman who was on duty at the time the accident occurred testified that he first heard a cracking noise caused by the breaking of the sidewalk, and then saw the earth embankment parting near the deepest point of the fill. He ran for his life, and reached solid ground just in time to escape going down with the torrent of earth and water, a striking bit of evidence as to the suddenness of the failure.

We show herewith a section of the embankment at its deepest point sketched according to the dimensions given above. It is surprising that so wide an embankment should have failed under a water pressure comparatively small. The important facts bearing on the cause of failure seem to be the suddenness with which it occurred, and that the bank stood for



Approximate Section of Embankment at Deepest Point.

eight days after the storm which raised the water behind it to a dangerous height, and finally failed when the water had fallen three or four feet. It appears evident from these facts that the clay embankment, containing enough sand and gravel to make it porous, gradually became thoroughly water-soaked and in a semi-fluid condition. When this fluidity reached a point in some layer where the resistance to sliding was less than the force due to the pressure of the water the embankment gave way, and with a suddenness which abundantly proves that it was thoroughly water-soaked, and of the consistency of mud rather than earth.

A NEW IDEA IN M. C. B. CAR COUPLERS.

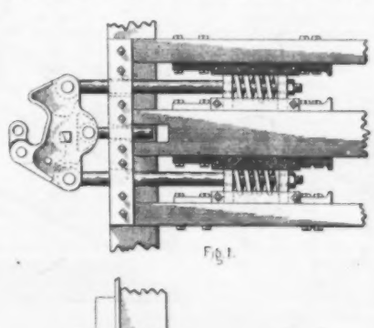
For a long time the weekly list of patents on car-coupling devices has contained little of practical value. The backwoods' inventors who have never heard of the Master Car Builders' Association continue to devise new schemes for car-couplings and doubtless each expects to reap a fortune from his invention. The patents issued on couplers conforming to the M. C. B. lines are taken out principally by those who wish to engage in their manufacture, and are more concerned to find some detail which they can make differently from manufacturers now in the field than to effect any real improvement.

But the invention illustrated in the accompanying drawings belongs in neither of the above classes. What its value may be only a practical trial can determine; but it is designed by a man fully conversant with every feature of the car-coupling problem, and it has enough promise of merit to justify a careful examination by railway officers.

The principal object of the invention is to reduce the numerous guard arm and knuckle breakages which occur with the present type of coupler, and which are caused principally by buffing blows and by strain in rounding sharp curves. An incidental advantage of great importance is that the strength of the draft rigging, the weak point in the present type of freight car, may be increased to nearly double what it is at present.

The inventor of the device illustrated is Mr. H. C. Buhoup, for many years past the Chicago representative of the McConway & Torley Co., and his experience has been such as to fit him for solving the remaining difficulties in the car-coupling problem as well, perhaps, as any man in the country. We quote as follows from Mr. Buhoup's patent specification:

It is well understood that couplers, especially of the "Janney" and similar types, commonly called "twin-jaw couplers," while especially designed as draft devices, are also called upon to perform the function of



A New Idea in M. C. B. Couplers.

buffers, and in performing this latter function are subjected to severe shocks and blows, which tend to their destruction by the breaking off of the ears or pivotal support of the knuckles, the guard-arm, and other exposed and unsupported portions of the coupler-head, which have to sustain at times the impact of the buffing blow. This defect is so great that at least 50% of the breakages in couplers occur from such causes. To overcome these objections and render the coupler durable and effective, I propose to so construct the same that it shall always yield in the line of force, so as to relieve the ears or guard-arm, as the case may be, from undue or destructive crushing force.

My invention embraces the combination with a car-coupler of two or more horizontally extending pivoted stems with suitable springs attached thereto, which permit the coupler to adjust itself to the line of force or draft, imparting to it a rocking or equalizing motion; also the combination with a car coupling of safety stops to prevent the separation of the coupling in case of fracture.

The device will operate as follows: When the cars are coupled, in rounding curves the stem on the inner side of the curve will yield and the one on the outer side will extend, thus equalizing and balancing the head while permitting it to adjust itself to the line of draft or force without (as at present) straining the body of the car. At the same time, in case of the vertical type pivoted nose, or Janney type of couplers, the wear on the knuckle is diminished or avoided, and, in buffing, in case the knuckle or the lugs of the head are struck by a link-pin, draw-bar or by a closed knuckle, the coup-

ling-head will yield on that side, converting the blow into a glancing one, which will diminish the force and prevent injury to or the breaking off of the parts, the coupler-head being immediately righted by the equalizing-stems as soon as the force or pressure is withdrawn.

In the accompanying drawings, Fig. 1 shows one arrangement of the device in which the two side stems take all the strain of pulling and buffing and the central stem is used only as a safety stop. It is suggested that it may be found preferable, however, to transmit the main portion of the strain through the central stem and make the side stems smaller, as shown in Fig. 2. The drawings accompanying the specification also show a simple link coupler head, which may be quickly substituted in case of the breakage of the regular head by merely drawing out the pivot pins.

Doubtless the coupler illustrated would be considerably heavier and more costly than the best of the M. C. B. couplers now on the market. Whether the diminution in breakages and break-in-twos which is claimed for the new device would be sufficient to offset this increased first cost, only an extended trial could certainly determine. The idea is at least a novel one, and the fruit of a careful and long-continued study of the coupler problem.

THE RENO CONTINUOUS PASSENGER ELEVATOR.

We are indebted to Mr. J. W. Reno for the accompanying illustrations of a continuous elevator which he has designed for use at elevated railway stations, retail dry goods stores, hotels, theaters and other places where the transfer of people from one level to another is necessary. This elevator was primarily designed for use in connection with Mr. Reno's system of underground rapid transit (Eng. News, Feb. 27, and April 2 and 21, 1892), but it has been modified to make its application general.

The general appearance of the elevator when in use is shown in Fig. 1. It consists of an endless inclined platform which moves at a uniform speed and upon which the passengers step and are transferred from one landing to the other. In addition to the platform there is a moving hand rail which serves to steady the passenger in his ascent. The platform is made up of series of cast iron lags, or sections, each 3½ ins. wide and 1 ft. 10 ins. long, and supported on cast iron rollers 2¼ ins. in diameter, linked together and running on tracks, as shown in Figs. 2 and 3. Each lag consists of a base plate upon which are grooved ridges 1 in. high and 1 in. apart parallel to the axis of the platform. In the grooves of these ridges are placed strips of rubber with the upper edge serrated to prevent slipping. At the landings are placed iron plates shaped like a comb, the prongs of which extend into the grooves, as shown in Figs. 2 and 3.

The mechanism for operating the platform consists of two pairs of sprocket wheels, the teeth of which engage with projections on the lags. The location of these wheels, one pair at the top and one at the bottom landing, is shown by the dotted lines in Fig. 1, and the details of their construction are shown in Figs. 2 and 3. The power, which is supplied by an electric motor, is applied to the shaft of the upper pair of wheels by means of the spur wheel shown in Fig. 3. This pair of wheels also supplies the power for moving the hand rail. All the other wheels, including those carrying the hand rail, are idlers. A wooden casing incloses the machinery, as shown in the cuts. The other details of construction are also plainly shown in the cuts and need no further description. The illustrations given herewith are for a single file elevator, but the details of construction of a two-file elevator are exactly the same, except that there is a moving hand rail on both sides, instead of on one side only.

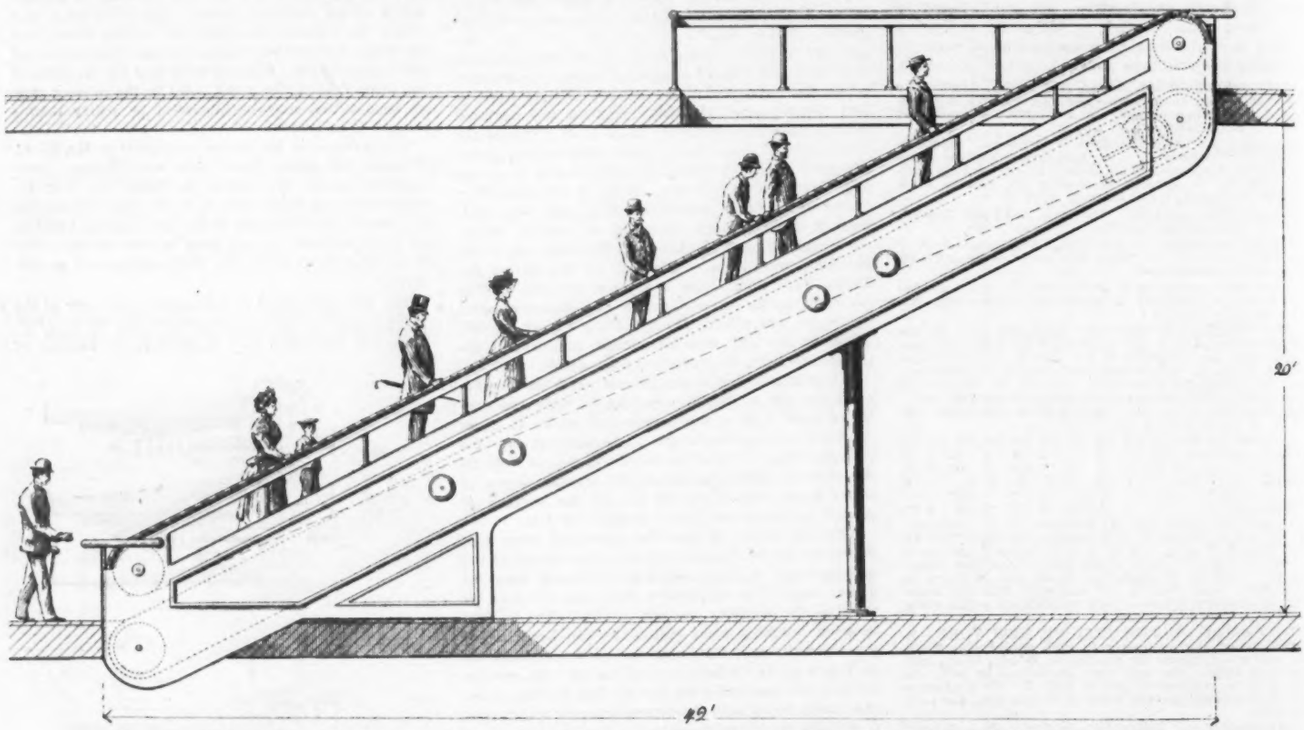


FIG. 1. SKETCH SHOWING RENO CONTINUOUS ELEVATOR IN OPERATION.

It would seem that the possible field for a successfully working elevator of this character would be considerable, especially in places where the traffic is quite continuous, as at the down-town stations of the elevated railways and on the Brooklyn Bridge during certain hours of the day. Of course the primary requisite in a system of transfer of any kind is that it shall be as free from offense and annoyances to its users as possible. This is especially true of an entirely new and unfamiliar system like the one illustrated, which also has to compete with the well known type of passenger elevator now in common use. An examination of the experimental elevator now in operation in Brooklyn, N. Y., has fully convinced us that there is little to be feared in this respect. With the platform moving at the rate of 70 ft. per minute no difficulty was experienced in stepping on or off, or in maintaining the foothold or equilibrium even without using the hand rail. For an aged or infirm person there might be danger of falling in carelessly stepping onto the moving platform without grasping the hand rail, but with an ordinarily able-bodied person the danger of falling would hardly be as great as in walking up stairs and the consequences of such a fall no greater. The elevator has, however, the disadvantage which every mechanism of this character must have of leaving nothing to the will of the passenger, who once on the platform must go to the top, a condition which can conceivably lead to serious consequences in case of a blockade. With sufficiently large landings and proper facilities for quickly stopping the machinery, however, the dangers from a blockade would be few.

The following details of general interest in regard to the safety, economy and possible modes of application of the continuous elevator are given by the inventor.

The object of this invention is to enable many persons to be lifted quickly from 15 ft. to 30 ft. The moving platform, made of iron lags or sections, being provided with longitudinal ridges between which the prongs of the comb shaped landing piece project, it will be seen that the foot of the passenger, resting as it does upon the ridges, will, when it arrives at this point, be gently slid up on the upper surface of the comb, and the slight friction thus produced will sufficiently retard the lower part of the body to cause the passenger to involuntarily step forward and thus make room for the person immediately behind him. The prongs of the combed landing are carried down to the bottoms of the grooves of the platform, which makes it impossible for anything, such as a lady's dress, to be caught. In fact, so perfect is this action, that cotton waste and rags have been thrown upon the platform of the machine now in operation and have been transferred to the combed landing without showing the slightest tendency to be caught.

The angle of inclination of the moving platform being 25° and its speed only 100 ft. per minute, there is no difficulty experienced in stepping upon the elevator. As the passengers can stand 18 ins. apart on the platform and are carried up as fast as they can step on at the bottom, it will be seen that the machine has a very large capacity. The maximum capacity of a single file elevator is approximately 4,000 passengers per hour, while that of a double file elevator, provided of course with a moving hand rail on each side, is twice as great. As the machine is perfectly balanced the power required is directly proportional to the number of passengers elevated, very little power being used in moving the machine itself.

It is evident that the electric motor is admirably adapted for running the continuous elevator because the speed required is constant and it is impossible to suddenly load the machine to its full capacity, since passengers can only step on one at a time.

Where the electric current can be had at 4 cts. per

HP. per hour, a simple calculation shows that theoretically 200 people can be elevated a height of 15 ft. for one cent by this elevator, and if we allow 50% for friction the cost to elevate one person, weighing 175 lbs., is thus shown to be 1-100th of a cent, an amount which hardly cuts any figure.

Of course it is not expected that this type of continuous elevator can or will compete with the ordinary vertical type in locations where the lift is considerable, and where also the traffic so great that the expense of elevator boys is not a serious consideration. But for short lifts of one, two or three stories it should save time to each passenger, and also carry more passengers, because it is continuous in its action. For these reasons it would seem to be especially suited for use in large retail establishments, apart from the saving in cost of elevator boys.

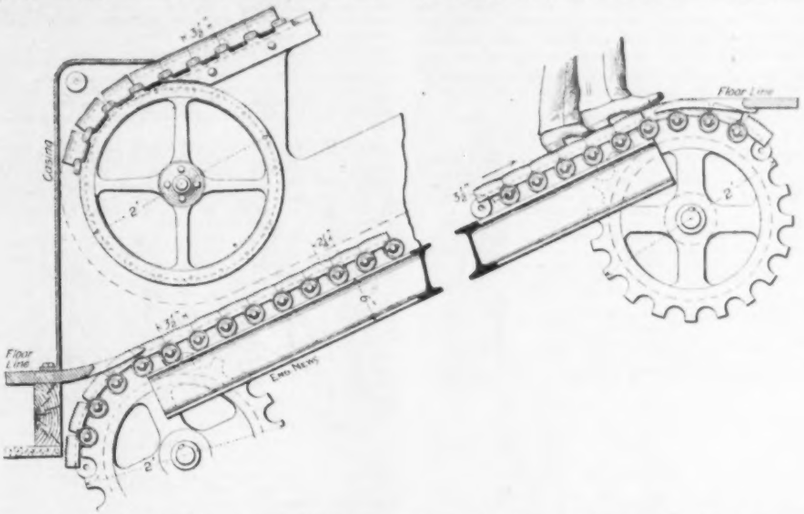


FIG. 2. LONGITUDINAL SECTION THROUGH CASING, SHOWING DETAILS OF SPROCKET WHEELS AND PLATFORM.

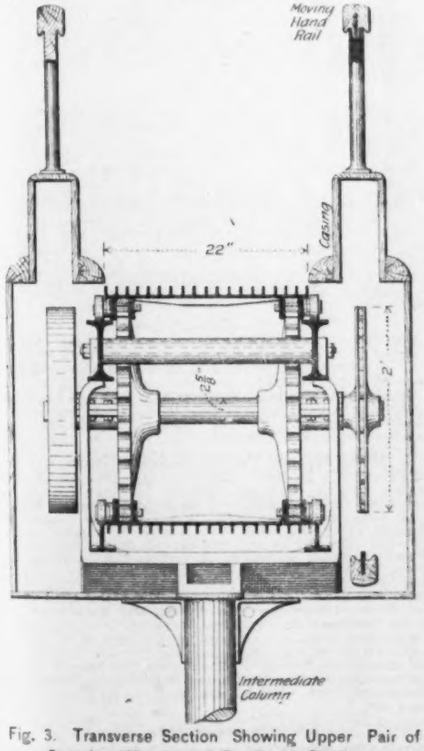


Fig. 3. Transverse Section Showing Upper Pair of Sprocket Wheels and Details of Platform.

In many office buildings and shops of moderate height also, especially when the number of passengers to be handled daily is hardly enough to warrant the employment of elevator boys, its range of useful application should be great, while for all kinds of one-story lifts, to railway stations or otherwise, it should be particularly useful, and for lifting baggage or freight as well as passengers.

WORLD'S COLUMBIAN EXPOSITION.

Terminal Interlocking and Signals.

The contract for the interlocking and signal plant of the extensive railway terminal at the Exposition grounds has been awarded to the Wuerpel Switch & Signal Co., of St. Louis, Mo. This company informs us that all the signal companies bid for the work and that Mr. Holcomb, Master of Transportation, decided that this company's bid was, under all circumstances, the most advantageous, but as the Wuerpel system was entirely new to him he decided that before he awarded the contract he would send a committee to St. Louis to examine the three plants which the company has in operation there. For this purpose he secured the services of Mr. W. McC. Grafton, Signal Engineer of the Pennsylvania R. R. lines west of Pittsburg, who, with Mr. E. G. Nourse, Mr. Holcomb's chief engineer, made a thorough examination of the plant, and upon their favorable decision the contract was awarded to this company.

The passenger terminal station at the Exposition grounds will be a three-story building 190×400 ft., with a covered platform 100 ft. wide and 650 ft. long, stretching across the ends of 36 tracks arranged in twelve sets of three tracks each, on a 12° curve. Beyond these terminal tracks will be a yard, with turntable, water tank, etc., from which extend the four main tracks. We shall publish plans and particulars of the terminal arrangements and plant later.

THE LATEST NEW EXPLOSIVE.

A new explosive compound is being developed by Prof. Silas R. Divine, chemist to the Rand Drill Co., and well known as the inventor of rackarock. Its peculiar virtue is that it is not exploded by concussions of even the most violent character, but yields readily when a fulminate of mercury detonator is applied. In appearance the explosive is a yellowish powder of high specific gravity. It does not deliquesce and does not have either picric acid or nitrate of ammonia as its active principle. In some recent experiments quantities of the new explosive were placed on a rock and pounded with a heavy sledge hammer without causing explosion.. A shotgun was loaded with a powder charge, and on top, separated only by a thin paper, a half ounce of the new explosive was placed. The gun was fired at a wooden box and portions of the explosive were found imbedded in a scantling inside the box. An old 18-pdr. carronade was next charged with 1½ lbs. of black blasting powder, and a shell made of linen and tarred cord was filled with 3 lbs. 9 oz. of the new explosive and fired vertically in the air. The shell was arranged with a time fuse terminating in a fulminate of mercury detonator. When fired the shell rose to an altitude of about 2,000 ft. and was exploded by the fulminate at that altitude. In another experiment two pieces of 1½-in. iron pipe about 7 ins. long were each filled with the new explosive and buried in the earth side by side. One of the tubes contained a fulminating cap; the other did not. The first tube was exploded and torn into small bits. The tube beside it was split open and badly smashed, but the explosive which it contained was unaffected.

These results indicate that the new explosive may be of especial value for military purposes, as it may solve the problem on which Dr. Justin has long been laboring, and with no small success, of firing shells containing a high explosive with ordinary powder.

Taking the energy of No. 1 dynamite as 100, the energy of this explosive is 86 per unit of weight or 138 per unit of volume. The high specific gravity makes it especially suitable for packing shells and bore holes, as great power is concentrated in a small space. It is not expensive or dangerous to make in comparison with other high explosives. It does not appear liable to injury or change in character from extreme cold or moderate heat, but, like all forms of powder, is non-explosive when wet. It is proposed to call the new explosive Randite.

HARDENING STEEL TOOLS.

A method of hardening steel tools which is claimed to give results superior to those obtained by any other process is described in a recent issue of "The Iron Age." The process is an expensive one on account of the careful manipulation required and the cost of the mercury bath; but it is claimed that tools hardened by it are not made brittle, as with the ordinary process of hardening, but retain their toughness to a surprising degree, so much so that there is no necessity for drawing the temper. We quote the description as follows:

For all fine work a clear flame from charcoal fire is always preferable to blacksmith's coal. Great care must be exercised to prevent an excess of air from the blast, as, otherwise, the oxidizing action is very rapid and causes scaling, as well as deterioration in the quality of the steel. The use of charcoal fire admits of the work being in plain sight during the entire heating and it can, therefore, be turned and shifted as required, in order to obtain perfect uniformity of temperature. Gradually heated to a barely visible red (in shadow), the article should be withdrawn from the fire and carefully covered with borax—the latter being preferably previously fused and pulverized. It will adhere to and glaze the surface like a coat of varnish.

As the heating progresses it may be necessary to repeat the application of borax to insure an absolutely perfect covering. The temperature may then safely be raised to a degree very considerably higher than would be safe were the steel unprotected from the action of the flame. A full, bright red for high tool steel is perfectly allowable, while without the borax the limit would be the traditional "cherry red." To insure perfectly uniform heating in all portions of the article it should be maintained at the required temperature for a sufficient length of time to allow a "soaking" or equalizing action, and immediately upon this point being assured the work should be quickly withdrawn from the fire and plunged into the mercury. It is of the utmost importance that the immersion be prompt and complete, and that the work be constantly moved about in the bath in order to prevent the local heating of the mercury and a consequent formation of mercurial vapor, which would interpose a film between the steel and the liquid metal, and by preventing actual contact interfere with the rapidity of the transmission of the heat of the steel into the mercury. Also, the article must be kept continuously in the bath until its temperature and that of the bath have become very nearly equalized, as, should its withdrawal be premature, there is not only a loss of the full possible degree of hardness, but the danger of warping and even breakage is imminent.

While the result of failure to comply with these necessary precautions will almost invariably be a complete failure, their careful observance will insure a quality of work which may almost be said to defy comparison with any other known method. The steel comes from the bath perfectly free from oxide or scale—due, of course, to the protection from atmospheric contact by the coating of borax. If any of the latter substance still adheres, its removal is easily effected. Occasionally some portions of the surface are coated with mercury—apparently by amalgamation, but it also is readily removed. The most highly finished articles may be hardened in this manner, and their polished surfaces come from the bath intact, except as to having assumed a whitish color.

But the most remarkable result is in the great strength and hardness of the steel. By all other known

processes extreme hardness is always attained at the expense of strength—that is, the greater the degree of hardness the more brittle under a breaking strain will it become. Strange as it may seem, however, by the process under consideration the strength and hardness appear to increase alike, and therefore the necessity for the subsequent operation of tempering, except where a very low degree of hardness is required, becomes unnecessary.

As a proof of the superior hardness of tools treated in the above manner, a test is described. Two graving tools are made from the same bar of steel, one by the process just described, the other by the ordinary process of water hardening. After being properly sharpened it is attempted to cut a groove in the face of each tool with the sharp point of the other. The mercury hardened point will do this successfully if the treatment has been properly carried out. It is also stated that a drill hardened in this way will bore a clean hole through a flat file.

Immigration is now running nearly 10% heavier than last year, when it was very large; a pretty sure index that business prospects are tolerably favorable. Russian emigration fell off largely in July; from most other countries it increased, and from Italy and Hungary largely. Still, British, French, German, Dutch, Danish, Swedish, Norwegian and Swiss emigrants, all of which may be called strictly kindred stocks, constitute 73% of the immigration. Until within the last two or three years they constituted nearly 90%.

The Japanese government contemplates the construction of six lines of railway, aggregating 800 miles in length. The purchase of the private railways by the state is also projected.

The single screw Cunard steamship "Umbria" has eclipsed her own remarkable record reported in our issue of Aug. 11. On her eastward trip across the Atlantic she made the run from New York to Queenstown in 5 d., 22 h., 45 min. The only east bound trip on record better than this is that completed by the "Teutonic" on Oct. 21, 1891, in 5 d., 21 h., 3 min. That a single screw vessel built nearly half a dozen years ago should be able to make such remarkable time and compete with the fastest of the new ocean greyhounds gives additional force to our recent remarks on the relative merits of single and twin screws. The double screw is undoubtedly a great safeguard in case of breakdown, but so far as speed is concerned it gives but little gain.

Since the preceding paragraph was in type the east-bound record has been lowered by the "City of New York" of the Inman line, which reached Queenstown on Aug. 23, having made the voyage in 5d. 19h. 57 min., or 1h. 6 min. better than the time made by the "Teutonic" last fall.

Russian petroleum production last year was about equal to that of the United States, the total, as given by the U. S. Consular reports, being a little less than 48,000,000 bbls. The production has increased, as in the United States, faster than the market could absorb it, and ruling prices last winter and spring were about 5 cts. per bbl. for immediate delivery. In 1890 as high as 50 cts. per bbl. was paid for crude oil at the wells. At the close of 1891 315 wells were producing oil, 122 wells were being cleaned and deepened, and drillers were at work on 112 new wells, making a total of 549 wells "in sight" against 404 on the same date a year previous. The total exports of petroleum and petroleum products from Russia in 1891 were 5,753,000 bbls. Exports from the United States were about 15,720,000 bbls.

In his evidence before the British Royal Commission on Labor, Sir George Findlay, General Manager of the London & Northwestern Ry., stated that there was invested in railway enterprise in the United Kingdom upward of $4,500,000,000; more than $215,000,000 was spent annually as working expenses for wages and materials, and the number of men directly employed constituted an army of 350,000. On the London & Northwestern Ry., 61,000 men were engaged, and during the last 30 years he had only had experience of three strikes, two of which had been settled by the directors conceding the legitimate demands of the men as regards their wages and conditions of labor; but when it came to the point of the secretary of a trades union dictating what vessels should or should not be dealt with at the company's docks, they felt bound to resist, and in that case the men failed. The true preventive of strikes he held was to be found neither in legislation or board of trade control, nor arbitration, but in the cultivation of a good understanding between the men and their employers, and in the establishment of sick, accident, and benefit funds fostered and assisted by the directors, so as to show that the employers take as great an interest in their moral and material welfare as a private employer would do in the case of valued servants. On the London & Northwestern Ry. during the last eight years, while the gross receipts had increased 12%, salaries and wages had increased 21%, hours had been diminished concurrently with improvement in pay, and Sunday labor had been reduced to a minimum; so that now it was an exception for a man to be employed more than one Sunday in three or four.

The following particulars of locomotive performance on the Louisville & Nashville R. R. are taken from the tables of the performance sheet for June, 1892, for which we are indebted to Mr. Pulaski Leeds, Superintendent of Machinery. In the average number of cars per freight train, and average cost per freight car mile, five empty cars are taken as equal to three loaded cars:

Number of engines in passenger service	101
" " " " freight service	244
" " " total	345
Average mileage per passenger engine	4,335 miles.
" " " freight engine	3,175 miles.
" " of all engines	3,514 miles.
Average cost of engine repairs per mile	3.90 cts.
" " " " running expenses per mile	14.47 cts.
Average consumption of coal per mile	73.33 lbs.
" miles per pint of oil	12.99 miles.
Percentage of empty freight cars	29.29%
Average number of cars per pass. train	4.99
" " " " freight train (loaded)	15.08
Coal consumption per passenger car mile	12.11 lbs.
" " " freight car mile	6.18 lbs.
Average cost per passenger car mile	3.20 cts.
" " " freight car mile	1.48 cts.
Weight of pass. trains, including engines	172.15 tons.
" " freight " " "	382.31 tons.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

PHILADELPHIA & READING.—The contractors, Shields & Nolan, of Reading, Pa., have about 75 men at work on the line from Logan Station to Frankford, Pa., 6 miles.

PENNSYLVANIA.—This company will build a branch to the Arlington National Cemetery, D. C., 2½ miles long.

ADIRONDACK & ST. LAWRENCE.—About 2,000 men are now at work on the 25 miles of this road between Raynor's Pond and a point three miles north of Old Forge, N. Y., yet remaining to be completed. It is expected that tracklaying will be completed on this section in a few weeks.

Projects and Surveys.

ULYSSES & PINE CREEK.—Chartered in Pennsylvania to build a railway from Perryville to Ulysses, Pa. Pres., Perry Bingham, Ulysses, Potter Co., Pa.

TROY & NEW ENGLAND.—Recent press dispatches state that the surveys for this projected line from Troy, N. Y., east to the state line have been commenced under the direction of John A. Yates. It is also announced that the surveys will be completed in about six weeks and that construction will begin by Oct. 1.

MT. HOLLY & BURLINGTON CONNECTING.—A railway company by this name has been chartered in Pennsylvania by W. H. Clough, of New York City; C. H. Gachel, Philadelphia, Pa., and Geo. Norris, of Jersey City, N. J. The charter empowers the company to use either steam, electric or pneumatic power. The capital stock is $100,000.

OSCAWANA & CORNELL.—Chartered in New York to build a standard gage railway four miles long from Oscawana station to the Croton River, Westchester Co., N. Y. Among the directors are Wm. H. Gale and Henry E. Nelson, of Sing Sing, N. Y., and Oliver W. Barnes and A. S. Houghton, of New York City.

RAPID RIVER & EASTON.—Chartered in Michigan to build a railway from Torch River to Kalkaska, Mich.

RHODE ISLAND & WESTERN.—It is announced that surveys have been begun on this long-talked-of railway from Providence, R. I., to Springfield, Mass., 74 miles. The company was chartered in 1881 and its charter was renewed again in 1889 and some surveying was done some years ago. The present surveys are under the charge of Engineers Cushing & Schofield, of Providence, R. I.

GEORGES VALLEY.—This company, which was chartered about three years ago to build a railway from Warren, Me., to Union Common Me., 8 miles, has entered into a contract with Jas. Mitchell, of Bucksport, Me., to construct its line. The contract calls for the completion of the road by Sept. 1, 1893, and the contract price is $100,000; of which $40,000 is in subsidies from towns along the route and $60,000 in the company's stock.

UTICA & UNADILLA VALLEY.—It is stated that this company has signed a contract with a construction company of New York city to build its proposed line from Bridgewater to New Berlin, N. Y., 20 miles, the work to be completed by April 25, 1893.

WILLIAMSPORT & NORTH BRANCH.—The contract for building the extension from Nordmont to Bernice, Pa., 18 miles, has been let to E. J. Gaynor, of Pottsville, Pa. Work, it is stated, will begin at once.

MUNCIE BELT.—Chartered in Indiana to build a belt transfer railway 9 miles long at Muncie, Ind. Among the directors are E. F. Osborne, F. D. Comstock, Geo. C. Cromwell and others, of Muncie, Ind.

MCKEESPORT & WILMERDING.—The length of this proposed railway between McKeesport and Wilmerding, Pa., noted last week, will be 3½ miles.

TOLEDO RIVERSIDE RY. CO.—This company has been chartered in Ohio to construct, acquire, lease and sell railways in Toledo and Lucas counties, Ohio. Among the incorporators are Jas. J. Robinson, David Robinson, Chas. E. Wiley and others.

Southern.—Existing Roads.

ABINGDON COAL & IRON.—The grading has been completed on the line from Abingdon to Damascus, Va., 15 miles, and tracklaying will soon begin and it is expected will be completed by Jan. 1, 1893.

MACON, DUBLIN & SAVANNAH.—Work on the extension of this road from Dublin to Savannah, Ga., will, it is stated, begin within two weeks and the line be rapidly pushed to completion.

ROANOKE, FINCASTLE & CLIFTON FORGE.—About 75 men are now at work on the 11.5 miles of this line between Fincastle and Cloverdale, Va. The grading is completed with the exception of a few large cuts and tracklaying will soon be begun. It is expected to have the line ready for traffic by Nov. 1.

ATLANTA & FLORIDA.—At the recent meeting of the stockholders of this company it was voted to build an extension from Fort Valley to Cordele, Ga., about 42 miles, and to issue receivers' certificates for that purpose. The country through which the line will run is quite level, affording light work and easy grades and curves.

RICHMOND, NICHOLASVILLE, IRVINE & BEATTYVILLE.—The prospects for the construction of the proposed extension from Irvine to Beattyville, Ky., about 35 miles, seem quite favorable. About 17 miles of the grading have already been completed. If the extension is completed by Feb. 28, 1893, the company will receive a bonus of $110,000.

CHARLESTON, CINCINNATI & CHICAGO.—In regard to the report that work would soon be resumed on this railway at an early date, the Jackson City, Tenn., "Comet" says: "The early completion of the Charleston, Cincinnati & Chicago Ry. is now almost assured. Mr. Kennefick, one of the principal contractors on this line, has notified his agent here that he will ship his teams, implements and hands from New York State, on Aug. 15, and that they would probably be here on Aug. 20, and things got into shape so that the work can be commenced on Sept. 1. McDonald, Shea & Co. will also be here ready to commence work on the road on Sept. 1. With all these and other facts in view, it now seems that the early completion of the road is assured."

Projects and Surveys.

JELLICO & BIRD EYE COAL CO.—This company will soon let the contract for building a railway from Jellico to Bird Eye, Tenn. Ch. Engr., W. C. Crozer, Knoxville, Tenn.

MISSOURI, EAST TENNESSEE & VIRGINIA.—Press dispatches state that this company has let the contract for building its various proposed lines in Tennessee to A. L. & J. H. Conners & Co. The principal offices are at 258 Washington St., Boston, Mass.

WEST VIRGINIA & MADISON.—Chartered in West Virginia to build a railway from St. Albans, W. Va., to a point near Guyandotte Mt., on Little Coal River, in Boone Co. Among the incorporators are L. Kessler, J. W. Topping, E. C. Colard and others.

MISSISSIPPI.—W. L. Williams will build a narrow gage logging railway four miles long in the vicinity of De Soto, Miss.

Northwest.—Existing Roads.

BRAINERD & NORTHERN MINNESOTA.—It is expected to have the first 40 miles of this road from Brainerd, Minn., northwest in operation by Oct. 1. There is talk of extending the road next year about 75 miles further toward Red Lake.

Projects and Surveys.

SIOUX FALLS WESTERN.—Chartered in South Dakota to build a railway from Sioux Falls to Forest City, S. Dak. Among the incorporators are D. L. McKinney, H. T. Corson, Chas. E. Johnson and others.

IOWA.—A company has been formed by a party of Charles City, Ia., business men to build a railway from Charles City to Marble Rock, Ia., about 12 miles.

SHULLSBURG & WESTERN.—Chartered in Wisconsin to build a railway from Shullsburg to Aetna, Wis., Among the incorporators are: Fred. Swift, New York City; H. A. Blood, Fitchburg, Mass.; and D. A. Brooks, of Boston, Mass.

SIOUX CITY, CHICAGO & BALTIMORE.—A special election will be held Aug. 29 to vote upon the advisability of granting a 2% tax in aid of this road.

Southwest.—Existing Roads.

SOUTHERN PACIFIC.—On account of the wet weather the work on the line from Iberia to Vermillion, La., has been somewhat delayed, but is now being rapidly pushed ahead.

NORTH GALVESTON, HOUSTON & KANSAS CITY.—The contract for constructing 16 miles of this proposed railway from Virginia Point to Houston, Tex., has been let to J. H. Barratt.

Rocky Mt. and Pacific.—Existing Roads.

EVERETT & MONTE CHRISTO.—An extension of a branch into the Okanogan country is being contemplated by this company. A preliminary survey has been made, and the surveyors report that the country through which the road runs is rich in mineral resources. The line as surveyed extends from where the Everett & Monte Christo R. R. crosses the divide, between Sauk and Stillaguamish rivers, down the south fork of the Sauk to the forks, up the north fork to Indian Pass, across the mountains, past the head of the Chelan, thence down the Twitsp and Methow and up the Oganogan to Loomiston, Wash.

WASHINGTON & COLUMBIA RIVER.—It is announced that this recently chartered railway company will absorb the Oregon & Washington Territory R. R. and build the proposed extension from Hunt's Junction to Portland, Ore., which was surveyed nearly two years ago.

Projects and Surveys.

MIDLAND TERMINAL.—Chartered in Colorado to build a railway from Fremont to Beaver Park, Colo.

SAN FRANCISCO & SANTA CLARA VALLEY.—Chartered in California to build a railway from San Francisco to Gilroy, Cal., 80 miles. The surveys, it is stated, have been completed. Among the directors are Wm. R. A. Johnson, Wm. P. Henly and Jas. Deltrick.

CRYSTAL RIVER.—This company has been chartered in Colorado to build a railway from Carbondale or Sand's Station, Colo., up the Crystal River Valley to

a point near the town of Elko, Gunnison Co., Colo, with branch lines to various points. Among the directors are Henry R. Wolcott, of Denver, Colo., and Paul Morton, of Chicago, Ill.

SAN FRANCISCO & GREAT SALT LAKE.—It is announced that the directors of this proposed line are making rapid progress toward perfecting a financial organization. It is claimed that the road, extending 260 miles, can be built and equipped for $12,000,000, and that the bonded indebtedness will represent the actual cost of building and equipping the road. In their opinion the road will have an earning capacity capable of sustaining the bonds, both as to interest and annual sinking fund requirements.

PAYETTE, SALUBRIA & NORTHERN.—Chartered in Idaho to construct a railway from Payette to Salubria, Idaho.

NELSON & FORT SHEPPARD.—In regard to the construction of this British Columbia railway, the Victoria "Colonist" says that though the road will be a mountain line, its construction will not be very difficult. It will be about 120 miles in length, running from the boundary line north along the Columbia River as far as Beaver Creek, thence along Beaver Creek until it strikes the main Salmon River and its western fork, thence along the Cottonwood-Smith Creek. From here it is probable a detour of from six to eight miles will have to be made to get down the west arm of the Kootenai River to reach Nelson. The bridging of the Pend d'Oreille River must be done during the coming winter, as in the summer months, more especially at the present season, the water is too high and the current too swift to work to advantage. The line runs through a first-class timber belt, especially along the Salmon River, where the timber is considered to be the best in the whole Kootenai country. It is principally white pine and hemlock and is especially valuable. Most of the line between Nelson on the north and the Pend d'Oreille River on the south runs through unappropriated lands, and it is said the principal owners of the lands which have been taken up, and through which it is proposed the line shall run, are the Davies-Sayward Co., who own large tracts upon the Columbia and Salmon rivers. It will open up the Kootenai and Kaslo-Slocan mining districts, where considerable development is now being made."

Foreign.

RIVAS, SAN JORGE & PALOSI.—This company has been chartered in New Jersey to build a railway in Nicaragua, Central America.

COLOMBIA.—A press dispatch from San Francisco, Cal., says: "S. O. Woods, a civil engineer of Los Angeles, is here on his way to Cartagena, United States of Colombia, where he goes as consulting engineer in the construction of a line of railroad from Cartagena to Magdalena, in the interior, a distance of 150 miles. The company by which he is employed is composed of Boston capitalists, and the road is projected as a feeder to the Nicaragua Canal. Cartagena will be one of the main points where steamers will touch when the canal is completed and the road will tap a rich country. It is estimated that the road will cost $10,000,000 to build."

ELECTRIC RAILWAYS.

BROCKTON, MASS.—Mr. B. H. Hooper, C. E., writes us that the Brockton & Holbrook Street Ry. Co. is building an electric road on the Thomson-Houston system, from Brockton to Holbrook, 5¼ miles, with prospect of running to Braintree, 4 miles further. It will be ready about Sept. 1. Gen. Man., H. B. Rogers. The Brockton Street Ry. Co. is about to change the motive power on the Belmont and Pleasant St. routes, from horses to the Thomson-Houston electric system, and work was commenced on Belmont St. last week. Gen. Man., H. B. Rogers.

BROOKLYN, N. Y.—The Brooklyn City Ry. Co., has awarded the contract for boilers to the Babcox & Wilcox Co., at $200,000, and to the E. P. Allis Co., for engines, at $300,000. The generators will be of the Thomson-Houston pattern.

BUFFALO, N. Y.—The contract for the construction of the Buffalo, Kenmore & Tonawanda Electric Ry. has been let to the Field Engineering Co., at about $125,000. D. F. Callahan is President of the railway company.

PATERSON, N. J.—The Paterson & Little Falls Electric Ry. Co. has been incorporated by A. H. Post, A. A. Van Voorhies and F. C. Van Dyke, to build a line from Little Falls turnpike to the Greenwood Lake R. R.; capital stock, $50,000.

SCRANTON, PA.—The Lackawanna & Wyoming Electric Transfer Co. has been organized to build a line 16 miles long to Factoryville; A. E. Burr, S. H. Jerryn and R. H. Holgate.

BEDFORD, PA.—The Bedford Electric Ry. Co. has been incorporated to build a line to Bedford Springs; capital stock, $15,000; Pres. John B. Robinson, Media, Pa.

NEW ORLEANS, LA.—The Berlin Iron Bridge Co., East Berlin, Conn., will design and erect the new buildings for the New Orleans & Carrollton Ry. The power house is 83 × 130 ft., with brick walls and an iron roof. The car shed, 130 × 140 ft., will be built entirely of iron.

NEW ALBANY, IND.—A project is on foot for adopting electric traction on several lines, and running the cars across the Kentucky & Indiana Bridge. Col. B. H. Young is interested.

MUNCIE, IND.—The Citizens' Street Ry. Co. has been organized by W. N. Whitely, of Springfield, O., and James Boyce and Geo. F. McCullough, of Muncie, to build an electric road through the city and to the suburbs, in competition with the steam motor system of the Muncie Street Ry. Co.

AURORA, ILL.—The Aurora & Chicago Interurban Ry. has been granted a right of way into the city. It is proposed to build and equip an electric road of the Boynton bicycle pattern from Aurora to Riverside, to connect with the elevated road now under construction from Chicago to that point. The right of way has been secured from Riverside to Aurora, and the road is to be built on a steel superstructure.

CHICAGO, ILL.—Work was commenced at Hillsboro Aug. 15 on the Chicago & St. Louis electric railway which has been described in our columns.—The West & South Town Street Ry. Co. proposes to operate cross-town lines by the overhead trolley system.

WAUKEGAN, ILL.—The North Shore Construction Co., $50,000, has been incorporated to build an electric road. Pres., Dunlap Smith.

CICERO, ILL.—The Cicero & Proviso Electric Ry. Co. will extend its road, purchase new equipment and increase its power plant at Ridgeland.

OAKLAND, CAL.—The Highland Park line will adopt electric traction, using double deck cars. A 500-HP. engine will be furnished by the Risdon Iron Works, San Francisco, and the General Electric Co. will furnish the electric plant.

SAN FRANCISCO, CAL.—The San Francisco & San Mateo Electric Ry. Co. will build a new power house and purchase generators and 20 cars.

HOUSTON, TEX.—The Houston Heights Street Ry. Co. has been incorporated by D. D. Cooley, H. F. McGregor and G. B. Hengen, with a capital stock of $100,000.

TORONTO, ONT.—The Toronto Street Ry. Co. opened its electric line on Aug. 10. It extends from the union station to Rosedale, 5 miles. There are to be 30 miles completed this year, and the entire 80 miles by next summer. The company has built 60 cars, 26 ft. long over platforms and 18 ft. over the body, each equipped with two Edison single reduction motors of 20 HP. The entire equipment will be 200 cars. The electrical work was done by the Cleveland Construction Co., Cleveland, O.

ELEVATED AND CABLE RAILWAYS.

PHILADELPHIA, PA.—The Quaker City Elevated Ry. and the Northwestern Elevated Ry. are to be built and operated under one management and arrangements have been completed with a syndicate to provide $14,000,000 for construction. This syndicate includes William Sellers (of William Sellers & Co.), Charles Harrison (of Harrison, Frazier & Co.), August Belmont, F. B. Esler and M. Reed (of Vermilye & Co.)

PASADENA, CAL.—Prof. Lowe states that the construction of the first section of the Pasadena & Mt. Wilson Ry. (Eng. News, July 14) will occupy about 3 months, and the second section about 6 months.

HORSE AND MOTOR RAILWAYS.

ABINGTON, MASS.—The Rockland & Abington Street Ry. Co. has been organized to build a standard gage line 12 miles long between Rockland, Whitman, Abington, Hanover, Weymouth and Brockton; capital stock, $60,000; Secy., Geo. W. Kelly, Rockland; Treas., C. N. Cobb, Abington.

McKEESPORT, PA.—The McKeesport & Wilmerding Street Ry. Co.; capital stock, $100,000; commences business with $20,000; Pres., A. W. Smith, McKeesport.

TOLEDO, O.—A railway to Edgewater is projected by Ellery Eaton, J. H. Ainsworth and J. A. Dawson. It is proposed to use Baldwin steam motors.

HIGHWAYS.

NEW YORK.—The contract for improving White Plains Ave., in Williamsbridge, has been let to Hyde, Hudson & Barton, of Williamsbridge, at $17,534.

NEW JERSEY.—The Road Committee of the Board of Freeholders met at the office of Mr. H. B. Willis, at New Brunswick, last week, to draw up the necessary specifications for bids for the building of a road from Plainfield to Metuchen. The road is to be 12 ft. wide, and covered with 8 ins. of stone.

OHIO.—The Board of County Commissioners of Lucas Co., at Toledo, O., will receive bids until Sept. 14 for macadamizing Stickney Ave., Toledo, outside the city limits.

NEBRASKA.—Elkhorn Township, Dodge Co., which some time ago voted bonds for the purpose of road improvements, has awarded the contract for the work to J. M. Morris & Co., of Grand Island. The contractors take the $5,000 bonds at par for their work and will grade up the roads of that township at the rate of 8 cts. per sq. yd., doing the work under the supervision of the town board.

BRIDGES, TUNNELS AND CANALS.

THOMPSONVILLE, CONN.—The contract for building the new bridge over the Connecticut River at this point has been let to the Berlin Bridge Co., for $60,000. It will consist of five 210-ft. spans, with a roadway 20 ft. wide.

BROOKLYN, N. Y.—Bids will be received until Aug. 29 for the construction of a bridge over the Newtown Creek. Clerk of the Board of Supervisors, Kings Co., Court House, Brooklyn, N. Y.

WILMINGTON, DEL.—A bridge is to be built across Brandywine Creek, at Washington St.

YPSILANTI, MICH.—There is talk of building a bridge over Huron River to cost $10,000.

WATER-WORKS.

New England.

PORTLAND, ME.—The recently incorporated Belleville Water Co. proposes to operate works in Cumberland Co.

FALMOUTH HEIGHTS, MASS.—A company has been organized, it is reported, to build works including a pump, windmill and 25,000-gallon tank.

AGAWAM, MASS.—There is some talk of forming a second company.

UXBRIDGE, MASS.—Engr. P. M. Blake, Hyde Park, has submitted plans for an additional supply from Crony Brook.

NEWPORT, N. Y.—Water Commissioners have been appointed and have organized as follows: Pres., E. Thornton; Secy., E. C. Spellman; Treas., D. P. Wooster. Probably works will be built.

Middle.

BRIDGETON, N. J.—It is reported that $30,000 improvements will be made at the pumping station.

KEYPORT, N. J.—The people have voted for works, it is stated.

MOORESTOWN, RIVERTON & PALMYRA, N. J.—Engr. J. W. Ledoux, of the American Pipe Mfg. Co., Philadelphia, has reported upon increased supply for the two companies supplying these places.

WEST ORANGE, N. J.—Two parties have been seeking a franchise, the Montclair Water Co. and men interested in the works which supply Summit. W. G. Snow, Montclair, represents the former and Engr. C. Ph. Bassett, Newark, the latter.

PHILLIPSBURG, BEAVER CO., PA.—The Monaca Water Co. has been incorporated; $21,000; Treas., John T. Taylor.

CRISFIELD, MD.—A franchise has been granted to John H. Buxton, Laurel. The supply will be from artesian wells if water can be found. There will be a stand-pipe.

Southern.

GRAYTON, VA.—The Grayton Water-Works & Improvement Co. has been incorporated; $500,000; John H. Dingee, John M. Wingman and Wm. H. Triol, Camden, N. J.

NEW BERNE, N. C.—The New Berne Water, Electric Light & Ry. Co., has been incorporated; $160,000.

AIKEN, S. C.—The Aiken Water Co. has been incorporated; $60,000; E. F. Fuller, Orange, N. J., J. E. Lopez, New York; B. F. Turner and F. B. Henderson, Aiken.

IRONATON, ALA.—It is reported that Wiley Hudson, Anniston, has a contract to build a dam for works here.

SHEFFIELD, ALA.—Improvements, including a new reservoir, are proposed.

CYNTHIANA, KY.—Plans for works made by Engr. W. H. Glore, Covington, Ky., have been accepted by the town. Two 750,000-gallon pumps, a stand-pipe, five miles of 10 to 4-in. mains and 50 to 70 hydrants are proposed.

North Central.

BOWLING GREEN, O.—The people have ratified the granting of a franchise to W. S. Coon & Co., Upper Sandusky. Estimated cost of works, $100,000; annual hydrant rental, $5,000.

SHREVE, O.—Works are projected.

UPLAND, IND.—The Upland Water-Works Co. has been incorporated; $5,000.

PETOSKEY, MICH.—The sum of $15,000 has been voted for improvements.

WHITE PIGEON, MICH.—The people have voted 125 to 63 for works.

WILLMETTE, ILL.—The Village has contracted for a distribution system for $124,000. Water will be bought from Evanstown at 8 cts. per 1,000 gallons for 20 years.

SANDOVAL, ILL.—Works are talked of with a supply from 120-ft. wells.

BAYFIELD, WIS.—Engr. J. T. Fanning, Minneapolis, has reported on a new supply for the company, by pumping to a reservoir.

Northwestern.

WOODBINE, IA.—The contract for works to be completed by Dec. 1 has been let to the Churchill Pump & Engine Co., Omaha, Neb., for $8,063.

AUSTIN, MINN.—Bids will be received until Sept. 6 for 5,900 ft. of 4-in. and 1,275 ft. of 3-in. water mains. J. Wold, Cy. Recorder.

BANCROFT, NEB.—A vote of 67 to 12 has been cast in favor of works.

BEAVER CITY, NEB.—An election will be held to vote on works designed by Engr. A. A. Richardson, Lincoln, Neb.

COLERIDGE, NEB.—Bonds for works have been voted.

LINCOLN, NEB.—The city has voted to issue $47,000 of bonds to extend the mains and enlarge the works.

GRAND FORKS, N. DAK.—Plans for a new pumping station will be prepared by the city engineer.

Southwestern.

BIG SPRINGS, TEX.—The town may be incorporated to enable it to secure works.

OAK CLIFF, TEX.—Three propositions for works are reported.

ASPEN, COLO.—The Maroon Water, Light and Power Co. has been incorporated; $250,000. Works were built in 1886 by a company.

Pacific.

GARFIELD, WASH.—It is reported that bids for bonds are wanted, it being thought certain that the people will vote to build works.

HARRINGTON, WASH.—The Harrington Township Co. has been incorporated; $50,000; it may build works.

SEATTLE, WASH.—Cy. Engr. Thomson has recommended an electric pump to raise water to supply Beacon Hill.

HEPPNER, ORE.—A 15-years' franchise has been granted to H. V. Gates.

KLAMATH FALLS, ORE.—H. V. Gates is interested in proposed water and electric lighting plants.

OAKLAND, CAL.—The scheme of the Blue Lakes Water Co. to supply Oakland, Stockton, Livermore, Haywards, San Leandro and Alameda through a conduit 98 miles long from Blue Lakes is again being discussed. It is said that construction has been started. Pres., T. G. Phelps; Engr., W. S. Proctor.

Canada.

DIGBY, N. S.—A water company is being formed. It is proposed to pump water from springs to a reservoir.

LACHINE, P. Q.—Bids for trenching and pipelaying are wanted until Sept. 1. Address Jas. W. Raitt, Secy.-Treas., Lachute Town.

IRRIGATION.

NEW COMPANIES.—The Grand River Ditch & Reservoir Construction Co., Glenwood Springs, Colo.; $100,000; Directors, H. W. Halleit, D. F. Webster and others. Deming Land & Water Co., Deming, N. Mex.; $700,000. Sierra Irrigation & Lumber Co., Fresno, Cal.; $300,000.

SEWERS.

CONCORD, N. H.—The Council has ordered the immediate construction of the sewers voted several months ago.

ROCHESTER, N. H.—The contract for laying the sewer pipe has been awarded to Joseph Bruner, at $25,812.

MALDEN, MASS.—Geo. A. Wetherbee, Cy. Engr., has submitted a report on the proposed sewerage system. He divides the city into drainage districts and assuming that every street will be built upon, estimates the total length at 339,873 ft. and cost at $500,050.

LOCKPORT, N. Y.—The Council has decided to build a system of sewers at a cost of $140,000 and to issue bonds to pay for the same.

PROVIDENCE, R. I.—The contract for about ten miles of sewer pipe has been awarded to the Portland Stoneware Co.

ROCHESTER, N. Y.—Plans are being prepared for sections 4 and 5 of the East Side trunk sewer. The West Side Sewer Commission has elected W. E. Crane engineer of the sewer and the survey will be made at once. It is expected that the contracts will be let by February next.

ORANGE, N. J.—The Empire Construction Co. has ceased work upon the main section of the sewerage system. The contract was awarded in June, 1891, at $239,174, and the company claims to have lost money in the work. Arbitration is proposed.

NANTICOKE, PA.—The Borough Secretary will receive bids until Aug. 29 for about 20,000 ft. of 8 to 24-in. terra cotta pipe sewers.

YORK, PA.—Proposals for plans for a sewerage system have been received from Waring, Chapman & Farquhar, and Samuel M. Gray, of Providence, R. I.

BRIDGEPORT, W. VA.—An election will soon be held to vote on the issue of bonds for $12,000 for sewers.

COLUMBUS, GA.—Plans prepared by Williamson & Earl, Engrs., estimate the cost of a sewerage system at $137,903.

BUCYRUS, O.—The City Clerk will receive bids until Sept. 6 for the West Charles St. sewer. It is claimed that the main sewer needs extending nearer to the river as its present terminus is practically in the city.

CINCINNATI, O.—The contract for a sewer in Bold Face road has been awarded to J. F. Deters at $84,000.

OBERLIN, O.—Bids will be received until Sept. 8 for 1,400 ft. of 8-in., 700 ft. of 10-in., and 10,500 ft. of 18-in. pipe sewers. W. B. Gerrish, Village Engr.

ELWOOD, IND.—Bids are asked until Sept. 12 for single ring brick sewers as follows: 40-in., 15-ft. cut, 2,380 ft.; 36-in., 12-ft. cut, 1,250 ft.; 30-in., 10-ft cut, 984 ft.; 24-in., 9-ft. cut, 1,550 ft.; 8 manholes; 18 catchbasins. H. S. Freeman, Cy. Engr.

INDIANAPOLIS, IND.—The bids opened Aug. 10 for the three main sewers have been rejected and the work will be readvertised.

MILWAUKEE, WIS.—It is proposed to put in a complete sewerage system at Whitefish Bay.

BELLEVILLE, ILL.—Plans for a system of sewerage have been prepared by Mr. Wickenden, Toledo, O.

MONMOUTH, ILL.—The Council is discussing a main sewer to cost about $34,000.

MINNEAPOLIS, MINN.—The Board of Aldermen has directed the City Engineer to prepare estimates for 32 sewers.

SALT LAKE CITY, UTAH.—Plans are nearly completed for the carrying off of the sewage by gravitation. The estimated cost is about $250,000.

STREETS.

NORWALK, CONN.—The Borough has voted to ask for bids for paving Main St. The estimate includes 11,410 cu. yds. macadamizing, at 85 cts.; and 1,970 sq. yds. granite paving, at $2.75.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Sept. 6 for 33 contracts, including 30 for paving with granite blocks.

HOBOKEN, N. J.—The City Clerk will receive bids until Aug. 31 for the improvement of Sixth St.

PHILADELPHIA, PA.—According to the estimate of W. W. Thayer, District Surveyor, the proposed boulevard will cost nearly $6,000,000, divided as follows: cost of property to be condemned, $5,624,000; construction with brick sidewalks and macadam driveway, $292,007, or with asphaltum driveway, $349,647.

PLYMOUTH, PA.—The contract for paving Main St. with vitrified brick has been awarded to Fred Hendler, Wilkes Barre, at $22,089.

NORFOLK, VA.—W. T. Brooke, Cy. Engr., writes us as follows: "There has been no special appropriation by our Councils for street work. We have an annual appropriation regularly for laying from 15,000 to 20,000 sq. yds. of block paving, in place of old cobbles used in foundations. This work is all done by our men and not let out to contract. Owing to the extreme scarcity of stone in this locality we excavate sufficiently to relay the cobble pavement carefully under the block, and get remarkably good results at a minimum cost."

CHATTANOOGA, TENN.—Bids will soon be asked for paving several streets.

CINCINNATI, O.—Bids will be received by the Board of Administration until Sept. 9 for the improvement of Conroy St. The City Auditor will sell, Aug. 27, additional paving bonds for $450,000.

DAYTON, O.—The City Controller will receive bids until Sep. 16 for improving Monument Ave., 5,426 sq. yds., and for paving Ludlow St., 7,400 sq. yds., with Hayden block, Hallwood block, asphalt, or brick.

HAMILTON, O.—The City Clerk will receive bids until Sept. 6 for four contracts.

MARIETTA, O.—A contract for paving 16,000 sq. yds. with A. O. Jones' best brick has been awarded to E. M. Ayers, Zanesville, at $23,000.

TERRE HAUTE, IND.—The lowest bid for paving Seventh St. was that of the Warren-Scharf Asphalt Paving Co., $110,170 with stone curb, or $110,425 with Parkhurst gutter and curb.

MATTOON, ILL.—The City Clerk will receive bids until Sept. 12 for paving, curbing and grading three blocks.

MONMOUTH, ILL.—The Council has rejected bids for paving several streets and the work will be readvertised.

FREMONT, NEB.—The Board of Public Works has been directed to ask for bids for paving in three districts.

SALEM, ORE.—A paving contract has been awarded to C. D. Rynearson & Co., at $27,656.

TACOMA, WASH.—The City Engineer estimates the proposed paving of Pacific Ave. with bituminous rock at $70,000.

WINNIPEG, MAN.—The Committee on Works will receive bids until Sept. 1 for paving Fourth St. South with asphalt.

STERLING, ILL.—The City Clerk will receive bids until Sept. 5 for about 12,812 sq. yds. brick paving, 4,400 lin. ft. curb, and 750 cu. yds. stone retaining wall.

ELECTRICAL.

SEATTLE, WASH.—The Board of Public Works will receive bids until Sept. 9 for an electric light plant for lighting the streets, public buildings and grounds of the city. The city will furnish the building.

BROCKTON, MASS.—We are informed by Byron H. Hooper, C. E., that the city is discussing the advisability of erecting a municipal lighting plant, and that he desires catalogues and other information concerning electrical apparatus in connection with the same.

PAWTUCKET, R. I.—Bids will be received until Sept. 20 for lighting the city for 1, 3 or 5 years. Fred Binford, Chn. Com.

EASTON, PA.—It is proposed to establish a plant to supply this place, South Easton and Phillipsburg with both arc and incandescent lights. Water power would be used from the Delaware.

ST. CLAIR, PA.—Bids will be asked for the erection of a plant.

CHARLOTTESVILLE, VA.—A plant will be erected by the Charlottesville & University Electric Light Co., to cost about $20,000.

OBERLIN, O.—W. B. Gerrish, Village Engr. and Water-Works Supt., writes us as follows: There is some promise of adding an electric light plant to our pumping plant within a year, but there is nothing definite as yet. It would be a 60-light dynamo, 80 HP. engine, and the same boilers would be used for both plants. The Oberlin Gas & Electric Co. will have an incandescent system running by Sept. 1. It has a 500-light incandescent dynamo and a 125 HP. engine, and may add an arc circuit.

CHICAGO, ILL.—The Chicago Edison Co. is reported about to build the largest electric light and power plant in the world. The cost will be $1,000,000, a large part of which will be expended in the foundation. The total horse power of the present plant is about 8,000, and the proposed horse power is 25,000.

PAW PAW, MICH.—The Paw Paw Electric Light Co. is being organized, and has secured a contract for street lighting for six years, at $62.50 per light per year for lights of 2,000 c. p., moonlight schedule. L. H. Harrison is president and treasurer, and the proposed capital is $40,000.

SEARCY, ARK.—Mr. Ben Isbell, Mayor, writes us as follows, concerning a proposed plant: The population of this city is about 3,000 to 3,500, and is destined to increase rapidly. Our city authorities have been considering the advisability of putting in an electric light plant, of which we know but little. We think, however, that from 300 to 500 lights can be put in; that the electric and water plant would run successfully together by the same machine power. I think we mostly need 16 c. p. incandescent, and small arc lights for street purposes. We would like to know something of the various sizes and the costs of the same. It would suit our convenience if some company would set up the plant and we would liberally patronize it; or we would contract for the putting in of the plant at a reasonable cost and pay for the same in annual installments. Please furnish us with figures as to the sizes and the cost.

TUCSON, ARIZ.—The Council has voted to award a contract for two years to the first company erecting a plant in the city.

NEW COMPANIES.—Steelton Light, Heat & Power Co., Steelton, Pa., $40,000; Treas., A. C. Landis. Point Marion Electric Light & Power Co., Point Marion, Pa.; $10,000; Treas., Wm. K. Maple, Greenboro. Waitsburg Electric Light Co.; Waitsburg, Wash.; $25,000; G. H. R. Preble and J. C. Onderdonk, Spokane, and J. R. McKinley, New Whatcom.

CONTRACT PRICES.

STREET WORK.—Elwood, Ind.—We are informed by H. S. Freeman, Cy. Engr., that contracts have been awarded as follows: J. W. Call, 6,970 sq. yds. paving with Canton standard brick, including 7,022 cu. yds. excavation, 32 per sq. yd.; 4,906 lin. ft. 5×24-in. curb, 60 cts. per lin. ft.; 700 ft. 5×12-in. flagging, 28 cts.; 4,630 ft. of 6-ft. brick walls, 60 cts.; Coons, Sheets & Co., Findlay, O., West Main St. improvement; about 2,200 lin. ft. at $9.24½ per ft. The street is entirely new and the work includes paving a 30-ft. roadway with Canton standard brick on 8 ins. broken stone and 2 ins. sand, with tar filling, constructing sandstone curbs, 6-ft. brick walks, 2-ft. brick crossings, flagging, underdraining with 6-in. tile, etc.; also about 2,174 lin. ft. with a macadam roadway, at $5.96 per lin. ft.

Camden, N. J.—Contracts have been awarded for paving, at 95 cts. per sq. yd. for rubble, and $2 for Belgian blocks.

Latrobe, Pa.—The contract for paving Depot St. has been awarded to Shick & Ondrizeck at 30 cts. per cu. yd. for grading, 55 cts. per lin. ft. for curb, $30 each for catch basins, and $1.49 to $1.58 per sq. yd. for paving, according to the brick used.

Massillon, O.—The bids for paving East Main St. with brick ranged from $1.06 to $1.32 per sq. yd. with tar, or 94 cts to $1.17 without tar.

Indianapolis, Ind.—Contracts for paving six alleys, 15 ft. wide, with brick upon concrete have been awarded to the Minnehaha Granite Co., at $1.74 to $1.89 per lin. ft.

SEWER.—Trenton, N. J.—The bids for the sewer in East State St. ranged as follows: 8-in., 85 cts. to $1.80 per lin. ft.; 10-in., 95 cts to $1.80; 12-in., $1.05 to $1.80.

IRON PIPE.—Reading, Pa.—The Water Board has awarded a contract for about 6,000 ft. of 16-in. pipe to the Reading Foundry Co. at $25.76 per gross ton, and 2¼ cts. per lb. for specials.

MISCELLANEOUS.

TIES.—Montreal, Que.—The Canadian Pacific Ry. will receive bids until Sept. 1 for 2,050,000 tamarack ties, to be delivered along the line of the road between Fort William and Brandon, Man.

STONE DAM.—Alberton, Md.—Bids are asked for a stone dam about 280 ft. long and 19 ft. from overflow to water level below. Jas. S. Gary & Son.

CRUSHING STONE.—Middletown, R. I.—Bids will be received by the Town Clerk until Sept. 17 for crushing and screening 5,000 tons of stone.

BRICK.—Jacksonville, Fla.—The County Commissioners will receive bids until Sept. 7 for furnishing and laying about 150,000 first quality Florida brick.

LEVEE WORK.—New Orleans, La.—The Commissioners for the Lafourche Basin Levee District will receive bids until Sept. 8 for 20 contracts.

DAM AND EMBANKMENT WORK.—Albany, N. Y.—The Superintendent of Public Works will receive bids until Aug. 30 for repairing the state embankment of Mud Brook, in Sherburne, and for raising the dam in the Beaver River, at Stillwater.

DRAINAGE.—Seattle, Wash.—The County Commissioners have authorized the straightening of the channel of the Sammamish River from Lake Sammamish to Lake Washington, a distance of 16 miles. A strip of land, a mile in width, lying along the channel will also be drained and fitted for cultivation. This work will make the river navigable for small steamers its entire course. F. F. Ames is County Surveyor, and M. Stixrud is Consulting Engineer.

GAS WORKS.—Seattle, Wash.—The Seattle Gas Works have been sold to St. Paul capitalists for $650,000, and the plant will be improved at an expense of several hundred thousand dollars.

West Point, N. Y.—Bids will be received until Sept. 19 for enlarging the Military Academy Gas Works. Capt. W. H. Miller, Asst. Q. M., U. S. A.

DRY DOCK.—Washington, D. C.—In consequence of the new eight-hour law the Navy Department will ask for new bids for the proposed drydock at the Brooklyn navy yard, the contract for which was recently awarded to John Gillies at $412,000.

DREDGING.—Albany, N. Y.—The Superintendent of Public Works will receive bids until Aug. 30 for dredging 34,500 cu. yds. from the west channel of the Hudson River at Coxsackie.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for a four-coupled dou le truck engine, weighing 100,000 lbs., for the Clarion River lumber road in Pennsylvania; they are building 5 passenger engines for the Brainerd & North Minnesota. The Brooks Locomotive Works, Dunkirk, N. Y., are building a six-wheel switching engine for the Duluth, Mississippi River & Northern. The Illinois Central is getting bids on simple suburban engines. The Pennsylvania is building a two-cylinder compound engine at its shops at Altoona, Pa.; it will have 7 ft. driving wheels. A 20-ton locomotive is wanted by Harris & Thornton, Chattanooga, Tenn. A 12-ton narrow gage locomotive, with cylinders 10×16 ins. and 36-in. drivers, is wanted by W. L. Wilcox, of De Soto, Miss.

CARS.—The Pullman Palace Car Co., Chicago, Ill., has completed 20 vestibuled palace sleeping cars for the Pennsylvania, to be used on the through service between New York and Chicago. The Barney & Smith Car Co., Dayton, O., has built 2 day cars and 2 vestibuled sleeping cars for the Chicago, Milwaukee & St. Paul; the latter are upholstered in gray cloth. The Gilbert Car Mfg. Co., Troy, N. Y., has built 2 combination cars for the Adirondack & St. Lawrence. The Illinois Central will place orders for 245 suburban cars with open sides and transverse seats for the World's Fair traffic; they are convertible into fruit cars, so that they will be of service after the exposition.

THE STANDARD CATTLE GUARD CO., Chicago, Ill., has recently shipped several car loads of guards to the Chicago, Burlington & Quincy, the Burlington & Missouri River, and the Grand Trunk, and reports a large list of recent sales. To meet the demand the capacity of the plant is to be doubled at once. Benj. Wolhaupter, C. E., is the patentee and manufacturer.

THE NATIONAL SURFACE GUARD CO., Chicago, has a contract for 325 guards for the Buffalo extension of the Lehigh Valley. It is said the price was 20% higher than that of any competitor. The company has also a contract for furnishing its guard for every grade crossing on the Boston & Albany.

COMPANIES.—Chicago Equipment Co., Chicago, Ill., locomotives, cars and railway appliances; R. H. Pugh, R. H. Dunham and H. R. Durkee. Pittsburg Rolled Axle Co., Pittsburg, Pa.; $350,000. J. S. Mackintosh, W. T. Williams and E. E. Shick. Pier Movable Sidewalk Co., Chicago, Ill.; to build a movable sidewalk on the pier at the World's Columbian Exposition; $150,000; Wm. E. Furniss, S. A. Treat and J. L. Silsbee. Safety Levee Co., Vicksburg, Miss.; $1,000,000; to operate Wright's improvements in levees and dams; Capt. C. E. Wright and A. Miller.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $18 for iron and $13.50 for steel. Pittsburg: $30; old rails, $19 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $17.75 to $18.25 for iron and $12 to $13 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.7 cts.; spike, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2.05 to 2.1 cts.; track bolts, 2.6 to 2.65 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 5²½% on black and galvanized butt-welded; 70 and 60% on black and galvanized lap-welded. Casing 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $16. Pittsburg: $13.25 to $14.50; Chicago: $13.25 to $15.

LEAD.—New York: 4 to 4.1 cts.; Chicago: 3.97 cts.; St. Louis: 3.9 to 3.91 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.4 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.9 to 2.1 cts.; steel plates, 1.95 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 for large lots, and 2.1 to 2.15 cts. for small lots; angles, 1.9 to 2 cts.; tees, 2.45 cts.; Z-bars, 2.15 cts.; universal mill plates, 1.85 to 1.9 cts. for iron and 1.9 to 2 cts. for steel; sheared steel bridge plates, 2.05 to 2.15 cts.; refined bars, 1.7 to 1.75 cts. for iron and steel; steel plates 1.85 to 1.95 cts. for tank, 2 to 2.2 cts. for shell, 2.1 to 2.2 cts. for flange, 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.3 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2.1 to 2.05 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2.15 to 2.25 cts.; steel plates, 2.3 to 2.4 cts. for tank, 2.3 cts. for shell, 2.75 to 3 cts. for flange.